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STAFF

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EDITORS RATTLE SPACE

RELEVANCY IN ENGINEERING

The younger generation is challenging their elders about the relevancy of many beliefs and actions. When those of us in the over 30 generation are able to respond rationally, we must admit that youth is often correct. It is interesting and somewhat distressing to apply the question of relevancy to science and engineering.

As an employer of technical staff, I find distressing the deluge of resumés of fresh new PhD's trained in alchemistry and levitation. The areas of their specialized training are somewhat more of the real world in that the subjects are more believable, but the need for these areas is equally remote. The Universities, which purport to be advanced and futuristic, are producing space scientists, the need for which has almost totally disappeared. The new graduates are innocent, but the establishment is guilty of a lack of relevancy in their training.

Those of us controlling professional publications can also be proved guilty of irrelevancy. The higher the quality of the technical publications, the more likely it is that the resulting papers will not be useful. The engineer-in-the-street simply cannot read the "best" technical publications. This technical snobbishness results in papers being written, reviewed, and published for a very small in-crowd. This closed club writes and rewrites papers for academic recognition and self-gratification, rather than to transmit information to the working level of the profession. Anyone doubting this observation as simply to go into a working group of engineers in industry or government and ask them for the references they use. The result will normally be the textbooks used in schools (almost independent of the years after graduation) and a handful of references from trade publications.

By trade publications, I refer to the magazines published for profit and normally provided without cost to the readers. Such magazines provide "popular science" articles for which the authors are usually paid. The leaders in technology consider trade magazines unworthy of their talents and avoid them. Why? As a writer for both class technical journals and trade publications, I have found much greater satisfaction from the trade journals. Articles in the technical journals are discussed in terms of existence theorems and at best are used as references in one or more esoteric publications; articles appearing in trade publications often generate letters, telephone calls, etc., indicating a significant level of interest. Further, such articles are referred to often by working engineers and it is a sincere pleasure to find such articles used for training courses in the "real world."

As leaders in the technical community, we should aim most of our efforts at upgrading the working engineer. The emphasis by the schools and professional societies on science, pure research, mathematics, technical complexity, etc., is basically irrelevant to the needs of most engineers or a broader range of society. Isn't it time to apply the criteria of relevancy to our technical work?

K. E. McKee

SPECTRUM

SPECTRUM is intended as a column for the expression of readership opinion and will appear as comment is available. It is hoped that it will provide a ground for intelligent controversy on subjects of concern to the shock and vibration community.

Letter to the Editors:

We have been asked to comment on Dr. R.H. Lyon's paper, "What Good is Statistical Energy Analysis, Anyway?" which appeared in Vol. 2 No. 6 of the DIGEST. In view of our interest in SEA, it is a pleasure to be able to make a few remarks. Dr. Lyon presents his personal overview of what SEA is all about, enumerates the sequence of steps required to complete a SEA analysis, and indicates how that type of analysis might be used in certain design problems. He closes with the observation that while design engineers should have been among the first to make use of SEA they have not done so. Why is this the case?

SEA provides a basis for predicting gross response properties in a structure in terms of gross properties of the system and the excitation. It is based upon concepts and methods of acoustics, statistical mechanics, and structural mechanics. The basic quantities of interest are mean energy, mean power flow among energy storage units, and mean energy dissipation. Energy balance is fundamental and a basic relation states that the mean power flow between two energy storage units is proportional to the difference in mean energy.

Numerous papers from the group at Bolt, Beranek and Newman Inc. have applied SEA to complex vibration problems with what must be admitted is reasonable success in a broad engineering sense. It is clear that in response problems where modal densities are high, interconnections complex, and excitations known only in gross terms, SEA offers an approach which is, in our opinion, attractive because it focuses on what is realistic. Once again, this being the recommendation of SEA, why have design engineers not taken to it?

We believe that there are two basic reasons why design engineers have not taken SEA into their tool chest. First, look back at paragraph two; notice the terms and ideas used. What structural dynamicists, sharpened at the hands of Timoshenko, Rayleigh, Ormondroyd, etc., would understand at first glance what is going on?" Few, if any! The basic presentation of SEA was in terms that could not be easily followed by those who could best use it. Moreover structural dynamicists feel a little insecure about SEA since the theoretical basis of the power flow relations is to date not fully validated. These relations have been derived for simple systems and/or under severe restrictions, but have been used for problems in which their validity has been inferred only from rather widely observed approximate agreement between SEA predictions and experimental data. Perhaps many structural dynamicists feel what others have written, namely, that to date SEA is still more art than science.

Second, the structural dynamicist more often than not thinks he can by detailed analysis get more accuracy out of a study than the basic data admit. Thus, they hold to the old tried and true methods even when they are unrealistic in their employment. We remember a Technical Session where SEA was presented when a member of the audience insisted that he would rather average after a detailed analysis than initially use average quantities suggested by SEA, ignoring that his averages were over results that were of doubtful significance to the problem at hand. Put another way, it is hard for a structures man to admit that he can only get ± 5 db accuracy in certain types of problems. Confidence in old reliable methods cannot (and should not) be broken easily. In our view, derivations of the basic relations of SEA which start from classical vibration results offer the surest way to entice structural dynamicists to SEA, an approach that has been shown to provide answers to some complex vibration problems that otherwise can be solved, if at all, only with great difficulty.

J. L. Zeman and J. L. Bogdanoff

Feature Article:

R. J. Scavuzzo*

EFFECT OF DYNAMIC REACTION ON FOUNDATION SHOCK INPUT

During shock caused by transient foundation movement, inertia loads of large structures tend to resist vertical and horizontal motions. If the foundation is relatively flexible, these inertia loads will alter the foundation motion and, therefore, the resulting shock forces. Two engineering fields in which this phenomenon of foundation-structure interaction is significant are underwater shock on naval equipment structures and seismic loads on structures from earthquake motions.

The engineering significance of dynamic interaction is well understood in naval shock. This phenomenon was first evaluated by scientists at the Naval Research Laboratory. Belsheim and Blake, summarize data collected on underwater tests in Ref. 1. Possible errors from designing with peaks of the spectrum response, which may be very large, are pointed out. O'Hara (Refs. 2,3) conducted a controlled test program on this "spectrum-dip" phenomenon. In this program the spectrum response curves from two tests on the same model are compared. The difference between these tests was that the natural frequencies of the model were altered by changing the spring stiffness so that the fundamental fixed base frequency of test II coincided with the peak of the spectrum response of test I. As a result, a dip occurs in the spectrum response of the second test where the peak occurred in the first test. Thus, this dynamic interaction altered the spectrum response curve of the first test by almost a factor of 10. Results of this test program showed that the spectrum response curve cannot be considered a constant for the type of shock and dynamic system investigated.

Other discussions on the spectrum-dip phenomenon are presented in Refs. 4 through 6. Notes on normal mode theory needed to interpret these data are presented in Refs. 7 through 10. Dynamic design methods are discussed in Ref. 11.

The significance of this phenomenon in earthquake engineering is not as well understood and research in this area is very active. This fact is pointed out in a recent publication by the National Academy of Sciences Ref. 12): "This problem -- the problem of defining the true interaction of soil and structure as the violent earthquake motions are transmitted from the soil particles to the portion of the structure imbedded in the soil -- is one of the most important, but least understood, topics in the entire field of earthquake engineering." The solution to this soil-structure interaction problem is much more difficult than the corresponding underwater shock problem. In the case of underwater shock, the velocity of the shock wave is almost constant and the shape of the wave can be accurately approximated by a decaying exponential function for conventional explosives (Ref. 13). Conversely, the characteristics of earthquake motions vary significantly and the soil stiffness, which can be related to the P and S wave velocities, varies more than an order of magnitude. Thus, the evaluation of this phenomenon in seismic engineering is inherently more difficult than the corresponding problem on naval equipment structures.

One of the first attempts to determine the influence of ground flexibility in building vibrations was made by Jacobsen (Ref. 14) in 1939. In this study the building was treated as a uniform cantilever beam; many approximations were made in representing the ground. The effect on the natural periods was estimated. Since that time many investigators have studied the effect of ground flexibility on seismic forces in building structures (Refs. 15,16). The general conclusion made by these investigators was that structure-foundation effects may be significant for low stiff buildings on soft soil. Thomson (Ref. 17) stated that, "for tall buildings the compliance ratings become large thereby approaching a rigid ground condition. For poor soil and low building the effect of the ground becomes important." This conclusion is similar to that made by Merritt and Housner (Ref. 18). From the latter study it was concluded that if building structures are stiff, reductions in the foundation shear forces can be large.

At the present time, very few experimental studies have been published in the open literature on soil-structure interaction effects. Some of the most significant measurements on this phenomenon were made on the Hollywood Storage Company Building during the 1952 Arvin-Tehachapi earthquake. Measurements were taken both in a parking lot, 112 ft west of the corner of the building, and in the east corner of the basement in both the north-south and east-west directions. The building is a long

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rectangular structure. In the east-west direction the length is approximately twice the height, and in the north-south direction the length is approximately one-third of the height. As a result the fundamental period of vibration is much lower in the east-west than in the north-south. An analysis of these measurements by Housner (Ref. 19) showed that the lateral foundation acceleration spectrum response curve in the east-west direction was reduced by approximately 40 percent from free field values. On the other hand, there was no significant change in the lateral foundation spectrum response in the north-south direction. Thus, a significant reduction occurred in the stiff direction of the building structure. This trend was predicted by the referenced analytical studies of this phenomenon.

More recently, Parmelee (Refs. 20 through 22) made use of normal mode theory to represent the structure and the Arnold-Bycroft steady state solution of the Lamb problem to determine the soil flexibility. Interaction effects for steady state conditions are evaluated with this method of analysis. In Ref. 23, Agabein, Parmelee and Lee concluded that "the influence of the flexibility of the foundation on the seismic response is significant. The physical properties that affect the foundation stiffness and damping characteristics are the shear wave velocity and Poisson's ratio."

Recently, a study was conducted on soil-structure interaction of nuclear power plants during earthquake loading (Refs. 23 through 29). Both finite element procedures and continuum analysis were used. Containment vessels of nuclear power plants are inherently stiff and heavy. Since the lateral foundation force for a structure that can be idealized as an N-mass system can be expressed as

$$F(t) = \sum_{j=1}^{n} M_j \omega_j^2 \int_0^t \ddot{u}(\tau) \sin\omega_j (t-\tau) d\tau \quad (1)$$

where

M_j = the effective modal masses,
ω_j = the modal circular frequencies, and
$\ddot{u}(t)$ = the lateral foundation acceleration,

the interaction force varies as the square of the modal frequencies and linearly with the modal masses. Thus stiff heavy structures will cause the most significant soil-structure interaction effects.

In this study, the significance of dynamic interaction effects was evaluated by comparing the spectrum response of the free-field ground motion to the calculated foundation motion. The free-field ground motion was defined as the motion of the ground surface at the same location as the structure with no structure present. Emphasis was placed on horizontal motions because they are the most damaging during seismic shock.

Chiapetta used the SLAM program (Ref. 27), which is a finite element stress wave propagation program, to evaluate this phenomenon. Three interaction problems designated as Surface Model I, Surface Model II and the Embedded Model were studied. A three-mass model consisting of a base mass, a containment vessel mass and an internal structure mass was used as a simple idealization of a nuclear power plant. The finite element mesh used to represent the soil was kept constant for all three cases. Properties used to define the soil are presented in Table I. Results from this study are also summarized in Table I in the form of a ratio of the acceleration spectrum response of the foundation to the acceleration spectrum response of the free field motion at the structure location. These results show that the seismic forces on the containment vessel caused by lateral foundation motion were reduced by a factor of two or more. Similar results were obtained by Isenberg (Ref. 28). During a very comprehensive study the effects of soil layers in the earth, "plastic" soil deformation, and soil stiffness on dynamic interaction were investigated.

In Ref. 26 the influence of rotational motion of the reactor containment vessel foundation on lateral shock was evaluated. This investigation was conducted with two objectives in mind: (1) to determine the magnitude of lateral structure accelerations caused by foundation rotation and (2) to determine if peak lateral structure acceleration can be estimated by adding the rotational spectrum and lateral spectrum responses. Results showed that accelerations caused by rotation of the base are similar in magnitude to those caused by lateral motion and, therefore, must be included in seismic analyses of nuclear power plants. Moreover, an analysis which is based on a rotational spectrum response cannot be employed because of the phase relationships between lateral and rocking foundation motions. The effect of foundation rotation is to reduce the lateral structural accelerations at the fundamental frequency of the largest dynamic mass. At this frequency the contribution of the rocking motion was out of phase with the contribution of the lateral motion for all cases studied.

TABLE I

EFFECT OF SOIL-STRUCTURE INTERACTION
ON RESPONSE OF CONTAINMENT AND INTERNAL SUPPORT STRUCTURES

Reactor Model	Lumped Mass	Fixed-Base Frequency of Mass, Hz	Horizontal Acceleration Ratio (Structure Acceleration / Free Field Acceleration)
Surface Model I	Internal Support Structure	5	0.176
	Containment Structure	4	0.380
Surface Model II	Internal Support Structure	7	0.278
	Containment Structure	4	0.391
Embedded Model	Internal Support Structure	5	0.224
	Containment Structure	4	0.482

Soil Properties: weight density = 0.283 lb/in.^{3}
Poisson's Ratio = 0.25 and shear wave velocity = 802 fps.

The general approach used in the analytical solutions presented in Refs. 23 to 25 was based on formulating the problem as an integral equation. From a solution to the Lamb problem, the lateral displacement u(t) could be related to a lateral force F(t) acting at the surface and varying arbitrarily with time in the following manner

$$u(t) = -C_1 \int_0^t F(\tau)d\tau - C_2 \int_0^t \int_0^{t-\tau} F(\eta)K(\tau)d\eta d\tau \qquad (2)$$

where C_1 and C_2 are material and geometric constants. By superposing the free field displacement $U_p(t)$ the equation can be written as

$$u(t) = -C_1 \int_0^t F(\tau)d\tau - C_2 \int_0^t \int_0^{t-\tau} F(\eta)K(\tau)d\eta d\tau + U_p(t). \qquad (3)$$

From the second time derivative of Eq. (3) and by substituting Eq. (1) into Eq. (3) an interaction equation in terms of the foundation acceleration can be developed. The free-field lateral acceleration $\ddot{u}_p(t)$ is prescribed and the foundation lateral acceleration $\ddot{u}(t)$ is evaluated by numerical interaction at each time step. By comparing input acceleration $\ddot{u}_p(t)$ to the output acceleration $\ddot{u}(t)$, the effects of dynamic interaction between the foundation and structure can be evaluated. Results of this study showed that interaction effects are significant for stiff heavy structures, such as nuclear power plants. In addition, the lateral response spectrum is reduced for this type of structure. The amount of reduction depends upon the soil stiffness, the structure weight, the structure modal properties and the frequency characteristics of the input wave. Reductions in the lateral spectrum may be as large as a factor of 5 or may be insignificant, depending on these factors.

This analytical approach has also been applied to the naval underwater shock problem (Refs. 30 through 35). In these studies the underwater explosion wave was approximated as a one-dimensional wave of the form $Be^{-\beta t}$. The hull of the vessel was considered to be a rigid flat plate of mass, M_h which is perpendicular to the wave front. Dynamic characteristics of the structure are expressed as an N-mass system. This analytical model can be expressed in the form

$$M_h \ddot{u}(t) = +2AP_o e^{-\beta t}$$

$$\int_0^t \left[\rho c A \dot{u}(\quad + \sum_{j=1}^{n} M_j \omega_j \sin\omega_j (t-\tau) \right] d\tau \qquad (4)$$

where

M_h = the effective hull mass,

A = the effective hull section,

ρ = water density, and

c = wave velocity.

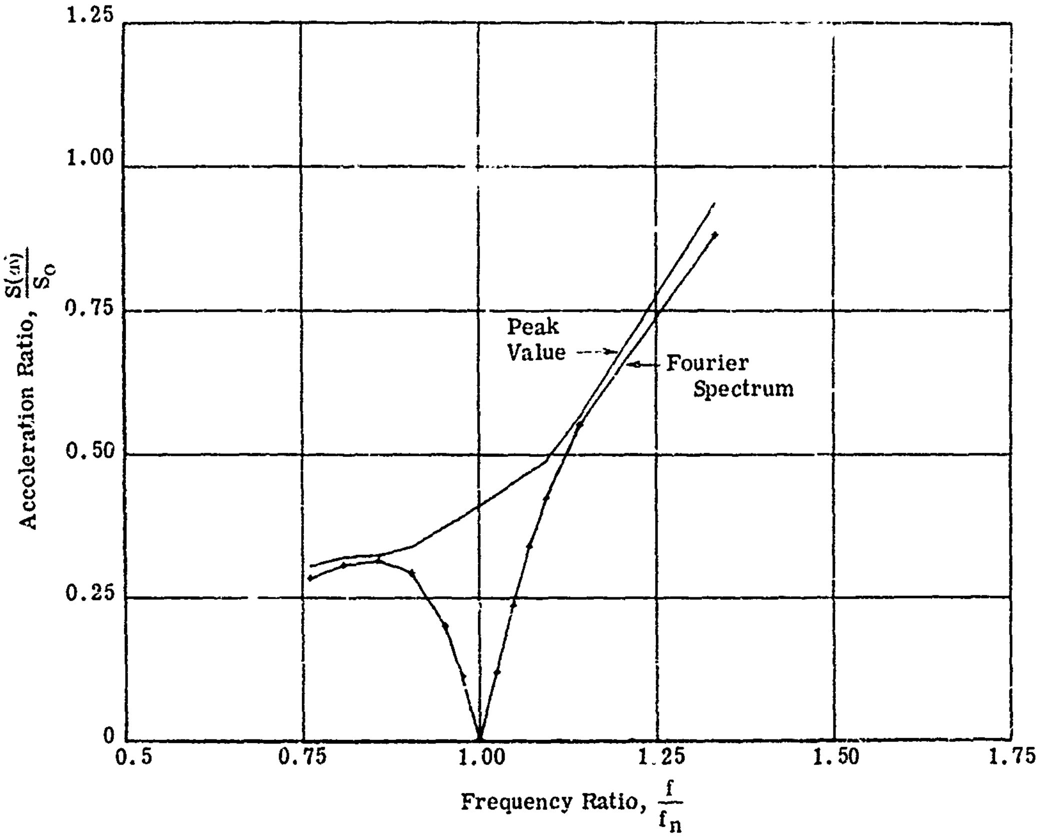

FIG. 1 SPECTRUM ACCELERATION RESPONSE SHOWN AS A FUNCTION OF THE FIXED BASE FREQUENCY OF THE STRUCTURE, f_n.

By solving this integral equation by numerical iteration the foundation motion $\ddot{u}(t)$ can be calculated for a given pressure pulse. A typical calculated spectrum response is shown in Fig. 1. A dip in the Fourier spectrum should be noted. Both the shape and magnitude of the calculated spectrum response were similar to those determined from experimental data.

In conclusion, dynamic interaction effects must be considered in the analysis of shock caused by foundation input. Loads on equipment structures are altered from this phenomenon when subjected to impulsive loads such as those that occur during underwater shock or when subjected to a long vibrating motion such as earthquake motions. Changes in shock loads on structures from interaction effects may be as large as an order of magnitude.

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SVIC Notes

The publication of The Dynamics of Rotating Shafts by R. G. Loewy and V. J. Piarulli is announced. This book is a current stock-taking of knowledge and technology associated with rotating shaft dynamics phenomena, and a status report of the problems remaining at this time. The subject is "familiar" in the broad sense to a very large number of people in science and engineering. It is, however, understood rather poorly by most -- including many mechanical designers directly involved with the creation of new rotating systems. Accordingly, the approach taken by the authors has been to attempt to be comprehensive and precise, without attempting to be complete.

Following an introduction, the monograph contains six topical chapters. These are devoted to three main topics: lateral motion, coupled lateral-torsion motion, and balancing. The latter two subjects are treated in two separate chapters. Since the preponderance of existing literature deals with the first subject, and because several important subphenomena must be treated within the context of "lateral motion," four chapters are devoted to that subject. These chapters attempt to present physical descriptions of the phenomena, to review important results, and to introduce the reader to the mathematical foundations. Stability and resonance are dealt with extensively, and forced response both at nonresonant conditions and in the presence of variable operating speed are discussed briefly. The examples chosen for description in physical terms are the simplest, both conceptually and mathematically, which could be thought of to illustrate the phenomena in question. The mathematical foundations are presented with sufficient rigor to provide both insight into realistic cases and a jumping off point from which someone familiar with engineering analysis (but not necessarily with rotational dynamics) can develop a useful capability in this field.

An extensive bibliography is presented including more than 540 references. These are cross-referenced in several index forms; for example, by author and by subject. In discussing the important phenomena encountered with typical shaft systems, references to the extensive literature are made throughout the text in order to allow the reader to pursue the complete, detailed treatments which could not be included in this review of the subject.

The complete contents are as follows:

Chapter 1 - Introduction
- Historical Perspective
- General Topical Perspective
- Monograph Overview

Chapter 2 - Introduction to the Phenomena: Lateral Shaft Problems
- Fixed and Rotating Reference Frames
- Instability
- Apparent Change in Frequency
- Critical Speed
- Shaft Flexibility vs Mount Flexibility
- Shaft Damping vs Mount Damping
- Effects of Gravity
- Progressive-Regressive Whirl
- Summary

Chapter 3 - Brief Review of Experience: Lateral Shaft Problems
- General
- Influence of Certain Parameters: Linear Effects
- Influence of Certain Parameters: Nonlinear Effects
- Prediction Methods

Chapter 4 - Mathematical Foundations: Lateral Shaft Problems
- Basic Causes of Unstable Shaft Motions
- Methods for Predicting Instabilities

Chapter 5 - Forced Bending Response and Transition through Critical: Lateral Shaft Problems
- Forced Steady State Response
- Response during Transition
- Effect of Damping on Transition
- Transition through Secondary Critical Speed

Chapter 6 - Coupled Bending and Torsional Motion
- Pure Torsional Motion
- Coupled Critical Speeds
- Free Coupled Vibrations: Natural Frequencies
- Effect of Torque Loading
- Instabilities

Chapter 7 - Balancing
- Three Classes of Imbalance: Static, Dynamic, and Flexible Shafts
- Balancing Methods and Theory
- New Concepts in Automatic and Self-Balancing

Chapter 8 - Conclusions

References

Bibliography

Author Index to Bibliography

Subject Index to Bibliography

Subject and Author index

The book is No. 4 in the Shock and Vibration Monograph series and may be purchased through the Navy Publications and Printing Service Office, Naval District Washington, Bldg. 157-2, Washington Navy Yard, Washington, D.C. 20390. The price is $6.00 by check or money order made payable to the Treasurer of the United States.

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Other

The proceedings of a recent anglo-dutch symposium on Environmental Engineering, The European Contribution are now available from the Society of Environmental Engineers, 68a Wigmore Street, London W1H 9DL, England.

The single volume contains 14 substantial papers embracing the space environment, reliability aspects, environmental specifications, acoustic testing or aircraft structures, problems in vibration and shock isolation, shock and bump testing, accelerated vibration testing, corrosion of metals and application of lasers for vibration and deformation analysis.

The symposium was held in Delft during the early part of 1970 and attracted international participation. It was organized jointly by the Society of Environmental Engineers and the Milieutechniek branch of the Royal Dutch Institution of Engineers.

ASME 91ST WINTER ANNUAL MEETING AND ENERGY SYSTEMS EXPOSITION

29 November - 3 December
New York, N.Y.

The 91st Winter Annual Meeting of ASME contained many sessions of interest to practicing shock and vibration engineers, including theme sessions on noise and bioengineering. It was an eventful meeting held at the New York Hilton and the Sheraton Park Plaza Hotels in New York City. Despite the current economic situation the attendance was near that of other years. A special symposium on noise abatement in industry was held in conjunction with this meeting.

For the shock and vibration engineer, the Robert Henry Thurston Lecture by J. P. Den Hartog was the highlight of the meeting. He was introduced by R. Plunkett who gave the opening remarks. As always, J. P. Den Hartog's presentation was entertaining, imaginative, and informative, and touched such interesting case histories as the Tacoma narrows bridge, the pogo effect on liquid fuel rockets, the gateway arch in St. Louis and a new acoustic particle coagulator used as an antipollution device. He described the fluid phenomena known as Karman vorticies that induced the Tacoma narrows failure. He noted the rather interesting fact that da Vinci identified this phenomenon in 1480. In addition, the St. Louis gateway arch is subject to the same phenomena if the wind is blowing in the proper direction. His revelation of a future vibration application to pollution control in the form of an acoustically resonating column tuned to get 170 dB noise level from a 400 Hz excitation was interesting. His lecture concluded with the novel Pentateuch formula which was derived to find the stability of a rotating hollow shaft with internal and external flow subjected to end twist and end thrust:

$$\frac{p}{p_c} + \left(\frac{\omega}{\omega_c}\right)^2 + \left(\frac{T}{T_c}\right)^2 + \left(\frac{V_{in}}{V_{inc}}\right)^2 + \left(\frac{V_{ex}}{V_{exc}}\right)^2 = 1$$

where

p_c = critical end thrust (Euler),
ω_c = critical speed,
T_c = critical twist (Greenhill),
V_{inc} = critical internal flow, and
V_{exc} = critical external flow.

All squared terms are without directional sensitivity.

Samuel Levy, Chairman of the ASME Applied Mechanics Meeting, was the toastmaster of the Applied Mechanics Dinner held at the Men's Faculty Club of Columbia University. The Timoshenko Medal was presented to Professor James Stoker by George Carrier. Professor Stokers' speech on a personal view of the theory of elasticity traced his beginning as an undergraduate at Carnegie Tech. under Max Frocht with "watered down elasticity" (strength of materials) to the present. His description of an interesting applied mechanics problem noted that it should include some mathematics and some mechanics. His personal view is that too many problems are "invented" and that matrix formulation would suffice for solution of problems rather than using the more abstract tensor notation. In addition he went on to say that some of the presently used abstractions are invalid.

There were many interesting sessions pertaining to sound, shock and vibration theory and applications. The Pressure Vessels and Piping Division sponsored a panel discussion on large-scale general computer programs. The panelists were R. H. MacNeal (MacNeal-Schwendler Corp.) P. V. Marcal (Brown Univ.), R. J. Melosh (Philco Ford Corp.), and J. Connors (Mass. Inst. Tech.). R. H. MacNeal discussed large-scale programs for dynamic analysis of random loading and referred to the NASTRAN program. NASTRAN is a large capacity, finite element computer program capable of performing static and dynamic analyses. It uses the latest techniques in modeling and numerical calculation. P. V. Marcal discussed the latest techniques and uses of nonlinear finite element analysis as they apply to static problems. R. J. Melosh discussed the types and magnitudes of errors that occur in finite element digital computer processing.

The Heat Transfer Division sponsored a session on flow induced vibrations in heat exchangers. H. Kerner Smith discussed vibrations in heat exchangers for nuclear service from the standpoint of failure mechanisms in heat exchanger tubes and methods of avoiding vibrations in the early design stage. Harry A. Nelms discussed some of the flow induced vibration problems associtated with the design of heat exchangers for nuclear service and reviewed some causes of failures. Richard Gerlach and Franklin Dodge

presented a critique of data used for flow induced vibration calculations and a new technique for obtaining data for more meaningful flow induced vibration calculations. S. S. Chen, G. S. Rosenberg and Martin W. Wambsganss presented an analysis of tube baffle impact during heat exchanger tube vibration and an application to design.

Raymond Bouche described the characteristics of instrumentation for vibration measurements in nuclear reactor components. H. J. Connors discussed the mechanism of self-excited vibrations of heat exchanger tubes. Y. N. Chen discussed flow induced vibrations in tube bundles with cross and parallel flows.

The Design Engineering and Applied Mechanics Divisions jointly sponsored the first theme session on the interaction of sound and structures. These papers were concerned with transducers, structures and enclosures subjected to noise sources. Specifically, the transmission of sound and vibration through panels and tie beams was analyzed using the method of statistical energy analysis. The sound transmission through an elastic enclosure closely coupled to a noise source was analyzed by M.C. Junger. His paper dealt with the problem of reradiated noise from the acoustically excited panels of a machinery enclosure.

The ASME Policy Board, ASME General Engineering and Industry Departments, and the Institute of Environmental Sciences sponsored the second in a series of three noise symposia. This session considered the problem of noise measurement. A mobile acoustical laboratory and a system for areawide measurement of aircraft noise were described. Some examples of noise measurements through the use of the noise measurement system were given. Louis Sutherland discussed standards for systems for measuring industrial or community noise. He discussed existing standards, where standards are needed, critical parameters in noise measurements, the role of noise measurement as opposed to noise monitoring, and the characteristics of noise measurement systems.

Some of the practical aspects and pitfalls of noise measurements and techniques for obtaining noise measurements in the vicinity of operating machinery were discussed.

The Design Engineering and Aviation and Space Divisions jointly sponsored a panel discussion on noise control in product design. Some of the principles and requirements for reducing noise in the design of machinery and the application of isolation and damping to the control of product noise were discussed. The application of mechanical signature analysis to the control of noise in mechanical equipment and some examples of techniques that can be applied to the control of noise in existing equipment were discussed.

The last of the three noise symposia included a discussion of fluid flow noise sources, examples of the use of vibration isolation to reduce transmitted noise, the application of vibration damping treatments to the control of noise, and a discussion on specifications for the measurement of noise and noise radiated from mechanical equipment.

In the important field of machine balancing, Neville Rieger gave a paper on the unbalanced response of an elastic rotor in damped flexible bearings at supercritical speeds. This technique has proved to be the first really practical method for balancing flexible rotors.

A series of theme sessions on biomechanical and human factors and the dynamic response of biomechanical systems proved to be interesting and comprehensive. Papers on investigations that quantify the mechanical characteristics of human joints and bones were presented by joint engineer-medical research teams. The use of the digital computer to simulate body response under shock and vibration environments was discussed.

Other sessions contained a wealth of shock and vibration related papers. A complete program listing of shock and vibration papers was given in Volume 2, No. 11 of the DIGEST.

R. Volin

R. Eshleman

JANUARY

VIBRATION AND SHOCK TESTING
Place: Los Angeles, Calif.
Dates: Jan. 11-15
Objective: The course is designed for quality assurance, evaluation and test personnel who are concerned with maximum reliability of missiles, aircraft, submarines, electronics, process industries, etc., where vibration and shock are hazardous environments. The seminar concentrates on modern laboratory practice, equipment and techniques with a minimum of theory and mathematics.

Contact: Tustin Institute of Technology, Inc., Box Q, Santa Barbara, Calif. 93102

DESIGN OF STRUCTURES FOR DYNAMIC LOADS
Place: University of California
Dates: Jan. 9 - Mar. 27 (San Francisco); Jan. 11 - Mar. 29 (Berkeley)
Objective: A 12-wk seminar (one meeting per week) will be given on the behavior and design of buildings under dynamic loadings such as earthquake, wind and blast. Emphasis will be placed on the earthquake-resistant design of conventional frame buildings and shear wall structures.

Contact: Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, Calif. 94720

ANALYTICAL FRACTURE MECHANICS
Place: University of California (LA)
Dates: Jan. 18-22
Objective: Elementary and advanced aspects of analytical fracture mechanics will be reviewed to provide a sound basis for practical or academic investigations of fracturing.

Contact: P.O. Box 24902, Continuing Education in Engineering and Sciences, University Extension, UCLA, Los Angeles, Calif. 90024

DESIGN OF ADVANCED COMPOSITE STRUCTURES
Place: University of California (LA)
Dates: Jan. 18-22
Objective: A comprehensive review of industry methods for designing and assessing the payoffs of aerospace structures with advanced composite materials will be given. Emphasis will be on practical aspects.

Contact: P. O. Box 24902, Continuing Education in Engineering and Sciences, University Extension, UCLA, Los Angeles, Calif. 90024

ENVIRONMENTAL SYSTEMS ANALYSIS
Place: University of California (LA)
Dates: Jan. 18-22
Objective: Integrated lectures and discussions by leading specialists will cover mathematical and statistical models in environmental science, economic and institutional aspects of environmental problems, systems ecology, systems analysis and its application to problems of regional water quality management, solid waste disposal, air pollution control, and environmental acoustics.

Contact: P. O. Box 24902, Continuing Education in Engineering and Sciences, University Extension, UCLA, Los Angeles, Calif. 90024

FEBRUARY

MODERN PHOTOELASTIC STRESS ANALYSIS TECHNIQUES
Place: Malvern, Pa.
Dates: Feb. 8-12
Objective: The ways in which photoelasticity is used to solve industrial problems will be emphasized. Modern model making techniques, automated methods for data collection, and a new concept in stress and design analysis using aluminum filled epoxy models will be explored.

Contact: Photolastic, Inc., 67 Lincoln Highway, Malvern, Pa. 19355

MARCH

AIRCRAFT NOISE, THEORY AND APPLICATIONS
Place: University of Tennessee
Dates: Mar. 15-19
Objective: The present knowledge on aircraft noise, its generation, effects and control will be surveyed. The emphasis of the discussion will be on the understanding of the physical nature of the noise sources based on available test and measurement data. As a joint effort with the Technical University in Aachen, Germany, this short course will be presented by lecturers from Europe and the United States.

Contact: M.J. Maynard, Manager, Short Course Program, The University of Tennessee Space Institute, Tullahoma, Tenn. 37388

ABSTRACTS FROM THE CURRENT LITERATURE

Note: Copies of articles abstracted are not available from the Shock and Vibration Information Center (except for those generated by SVIC). Inquiries should be directed to library resources, authors, or the original publishers. Reports may be ordered from the National Technical Information Service, Operations Division, Springfield, Virginia 22151.

ANALYSIS AND DESIGN METHODS

ANALOGS AND ANALOG COMPUTATION

71-1

SIMULATION OF SOUNDS OF HARPSICHORD AND PIANO BY ELECTROMAGNETIC STRING STIMULATION
Müller, H.; Schildbach, M.; and Wolf, D.
Acustica 23 (3), 156-159 (1970)

Key Words: electromagnetic excitation, strings

An electromagnetic system used for the actuation of string vibrations is described. The timbre can be tuned to that of a harpsichord or a piano. As the input voltage a unit step function is suitable for generating harpsichord sounds, while the same input function filtered by RC-lowpass networks yields sounds very similar to those of a piano.

ANALYTICAL METHODS
(Also see No. 76)

71-2

STEP FUNCTION RESPONSE OF NONLINEAR SPRING MASS SYSTEMS IN THE PRESENCE OF COULOMB DAMPING
Bapat, V.A. and Srinivasan, P.
J. Sound and Vibration 13 (1), 51-65 (Sept. 1970)

Key Words: Coulomb friction, mass-spring systems, nonlinear systems, transient response

The transient response of nonlinear spring mass systems with Coulomb damping, when subjected to a step function is investigated. For a restricted class of nonlinear spring characteristics, exact expressions are developed for the first peak of the response curves, and the time taken to reach it. A simple, yet accurate linearization procedure is developed for obtaining the approximate time required to reach the first peak, when the spring characteristic is a general function of the displacement. The results are presented graphically in nondimensional form.

71-3

STRUCTURAL OPTIMIZATION IN THE DYNAMICS RESPONSE REGIME: A COMPUTATIONAL APPROACH
Fox, R. L. and Kapoor, M.P.
AIAA J. 8 (10), 1798-1804 (Oct. 1970)

Key Words: dynamic response, framed structures, natural frequencies, optimization, structural synthesis

A structural optimization problem with design requirements on the dynamic response and frequency characteristics of the structure is solved. A central concern of this work is the problem inherent in treating systems with many degrees of freedom. A model of a simple planar truss-frame with both distributed and concentrated mass is used for an exploratory study. A "direct" optimization method (the method of feasible directions) which consists of a design-analysis cycle is used. Computationally efficient schemes are given for the necessary derivatives of maximum response and natural frequency. Numerical examples are given and computational effectiveness is indicated.

71-4

FRAMED DOME DYNAMICS AND LOWER BOUND TO THE FUNDAMENTAL FREQUENCY OF STRUCTURAL SYSTEMS
Hsu, Michael Bing-sun
City Univ. N.Y., 156 pp (1970)

Key Words: distributed parameter method, domes, free vibration, lumped parameter method, matrix methods, mode shapes, natural frequencies

A new method for obtaining a lower bound to the smallest eigenvalue of a real, finite, linear system is developed. The computation of this lower bound involves only elementary operations on

the elements of the coefficient matrix of the system. The method is used for finding a lower bound to the fundamental frequency of structural systems. A dynamic experiment of the framed dome is designed and performed in order to study the accuracy of natural frequencies obtained from lumped parameter analysis.

Univ. Microfilms 70-12,657
(Ann Arbor, Mich.)

71-5

SELECTION OF THE PARAMETERS OF CURVILINEAR CONCENTRATORS TO GIVE A PREDETERMINED OSCILLATION FREQUENCY
Buturovich, I. Kh. and Kim, K. D.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 179-183 (Oct./Dec. 1970)

Key Words: instrumentation, ultrasonic vibration

A method is given for calculating the parameters of curvilinear ultrasonic concentrators where: the axis of the concentrator represents an arc of a circle of radius r; the radial dimension of the cross section of the concentrators is much smaller than the radius of curvature ($b \leq 0.2r$); and the axis of the concentrator moves in the symmetry plane. The analytic method is geared to determine the resonance length of the concentrator and vibration amplitude distribution over its length at a given frequency.

71-6

THE VIBRATION OF SHALLOW SHELLS HAVING POINT SUPPORTS
Nemergut, Paul J.
Wright-Patterson AFB, 27 pp (July 1970)

Key Words: numerical techniques, shallow shells

A method of analyzing a simply-supported thin shallow with a point support located interior to the boundary is presented. The problem reduces to finding a stress function from which all quantities may be determined. Application of the boundary and continuity conditions gives the 16 necessary equations for solution. A numerical procedure is presented which involves the inversion of a 16 x 16 matrix.
AD-710208

71-7

STRUCTURAL OPTIMIZATION OF A PANEL FLUTTER PROBLEM
Plaut, Raymond H.
Brown Univ., 16 pp (1970)

Key Words: flutter, optimization, panels

A new development in panel flutter concerns the structural optimization of panels in order to minimize the panel weight while satisfying certain flutter requirements. An approximate method for obtaining the optimal panel design is proposed and calculations are performed for a panel with segmentwise constant mass distribution. The results, while only approximate, indicate that significant savings in weight may be possible with the use of nonuniform panels.
AD-709955

71-8

THE EFFECT OF LOCAL MODIFICATIONS ON THE EIGENVALUES AND EIGENVECTORS OF DAMPED LINEAR SYSTEMS
Pomazal, Robert John
Mich. Tech. Univ., 118 pp (1969)

Key Words: eigenvalue problems, linear systems, modeling

An analytical procedure for determining the effect of localized stiffness, damping, and inertia changes on the eigenvalues and eigenvectors of linear vibration systems is presented. In this procedure the known eigenvalues and eigenvectors of an unmodified system are used to generate the modified eigenvectors and modified characteristic equation directly, without solving the modified eigenvalue problem explicitly. The primary advantage of this method lies in the ease with which the solution of the modified system is obtained; the modified characteristic equation is of a form which is ideally suited to numerical solution by the Newton-Raphson iteration procedure, and the modified eigenvectors are evaluated by simple matrix multiplications.

Univ. Microfilms 70-13,559
(Ann Arbor, Mich.)

INTEGRAL TRANSFORMS

(Also see No. 37)

71-9

FORCED TORSIONAL VIBRATIONS OF THIN SPHERICAL SHELLS
Anderson, Gary
Watervliet Arsenal, 35 pp (June 1970)

Key Words: boundary value problems, forced vibrations, spherical shells, torsional vibrations

The axisymmetric torsional oscillations of a thin spherical shell are determined. The method of determination of the integral transform which is appropriate to remove a certain combination of partial derivatives from a partial differential equation subject to a variety of boundary or boundedness conditions is developed.
AD-711525

STATISTICAL METHODS
(Also see No. 22)

VARIATIONAL METHODS
(Also see Nos. 69, 70)

NONLINEAR ANALYSIS
(Also see No. 21)

71-10

ON THE PROBLEM OF VIBRATIONS OF A SYSTEM WITH A NONLINEAR CHARACTERISTIC SUBJECTED TO A RANDOM FORCE
Dimentberg, M. F.
Prikladnaya Mekhanika 2 (10), 10-15 (1966)

Key Words: random excitation

The combined probability density is found for the generalized coordinate, velocity and acceleration in a system with a piecewise linear characteristic. The system is subjected to an exponentially correlated random disturbance. In additon, an estimate is given for the error of the approximate value of the mean square of acceleration for a system with a continuous characteristic having a bounded derivative.

NUMERICAL ANALYSIS
(Also see Nos. 25, 58, 59, 61)

71-11

A CORRECTION OF THE APPROXIMATE SOLUTION OF THE PROBLEM OF NATURAL VIBRATIONS OF A PLATE IN A NONCLASSICAL FORMULATION
Klyuchnikova, V. G.
Prikladnaya Mekhanika 2 (12), 27-32 (1966)

Key Words: approximations, flexural vibrations, method of integrodifferential equations, natural frequencies, plates

The problem of determining the lowest frequency of natural vibrations of a plate with free boundaries is solved by the method of integrodifferential equations. The latter are obtained from the general equations of the three-dimensional theory of elasticity without any auxiliary statics and geometrical hypotheses and assumptions. The functions approximating displacements are chosen in the form of series arranged by powers of the z coordinate. These functions are also obtained analytically on the basis of the algorithm of N. A. Kil'chevskii. The boundary conditions are satisfied by means of a correcting load applied to the edge surface of the plate.

STABILITY ANALYSIS
(Also see Nos. 34, 54, 91, 98)

71-12

THE EXISTENCE AND STABILITY OF PERIODIC SOLUTIONS FOR QUASI-LINEAR n-th ORDER DIFFERENTIAL EQUATIONS
Fabry, C.
Intl. J. Nonlinear Mech. 5 (3), 447-463 (Aug. 1970)

Key Words: periodic response, stability

The existence and stability of periodic solutions of quasi-linear n-th order differential equations is studied by a method closely related to that of Cesari-Hale. When the method is applied to these equations in nonmatrix form, it is possible to use certain classical methods in the theory of linear differential equations, particularly the method of complex amplitudes (or the method of impedances) and the development into Fourier series. (In French)

71-13

DYNAMIC SNAP-THROUGH STABILITY OF THE NONLINEAR, ELASTIC, PLANE STRAIN, FREE VIBRATION OF A SHALLOW CYLINDRICAL SHELL
Ovenshire, Lee James
Univ. Mich., 154 pp (1969)

Key Words: cylindrical shells, equations of motion, free vibration, shallow shells

The dynamic snap-through stability of the nonlinear, elastic, plane strain, free vibration of a shallow circular cylindrical shell is studied using equations of motion based upon thin-shelled theory. Critical configurations, i.e., solutions to the equations of motion that are independent of time are derived for general linear elastic bending restraints against rotation at the boundaries. The strain potential energy for configurations with no bending restraints is presented. Based on the energy of the critical configurations, a stability sufficiency condition is determined.

Univ. Microfilms 70-14,611
(Ann Arbor, Mich.)

71-14

BOUNDS ON MOTIONS OF SOME LUMPED AND CONTINUOUS DYNAMIC SYSTEMS
Plaut, R. H. and Infante, E. F.
Brown Univ., 31 pp (1970)

Key Words: arches, columns, continued parameter systems, lumped parameter systems, plates, stability

Lumped and continuous systems subjected to general dynamic loads or perturbations are considered. The motions of these systems are assumed to be described by ordinary or partial

differential equations with time-varying forcing terms. Upper bounds on the motions are derived with a Lyapunov type approach. The results are applied to some structural dynamics problems; displacement bounds are determined for elastic columns, plates, and arches; and sufficient conditions for stability of arches against snap-through are obtained.
AD-710787

MODELING

(Also see Nos. 8, 14, 17, 36, 44, 55, 72, 78, 80, 88, 104, 105)

71-15

FREE VIBRATION OF RING-STIFFENED CYLINDRICAL SHELLS
Al-Najafi, A.M.J. and Warburton, G.B.
J. Sound and Vibration 13 (1), 9-25 (Sept. 1970)

Key Words: circular shells, cylindrical shells, finite element techniques, mode shapes, natural frequencies

The finite element method, using axisymmetric elements, is used to investigate the natural frequencies and mode shapes of thin circular cylindrical shells with stiffening rings. Each stiffening ring is treated as a discrete element. The method has the advantage over most approximate analyses of being applicable to any shell and ring configuration. It is shown that natural frequencies can be determined with adequate accuracy in comparison with new and previously published experimental results, and with the few available exact theoretical results.

71-16

NATURAL FLEXURAL WAVES AND THE NORMAL MODES OF PERIODICALLY SUPPORTED BEAMS AND PLATES
Gupta, G. Sen
J. Sound and Vibration 13 (1), 89-101 (Sept. 1970)

Key Words: beams, natural frequencies, normal modes, plates

The free vibration of beams and plates over supports at regular intervals is analyzed using the knowledge of natural flexural waves and the associated propagation constants. It is shown that the conditions at the extreme ends of a finite, periodic structure, permit only certain discrete values of the propagation constant. These, in turn, dictate the distribution of natural frequencies in the frequency spectrum. The whole analysis, when compared to the conventional methods, simplifies the problem of determination of natural frequencies of such structures, gives a better physical understanding of the phenomenon involved, and affords a simple graphical method of determination of natural frequencies of periodically supported beams and plates.

DIGITAL SIMULATION

(Also see Nos. 80, 101, 102)

71-17

STRUCTURAL DYNAMICS PROGRAMS
Murray, M.T.
Admiralty Res. Lab. (England), 33 pp (May 1970)

Key Words: computer programs, mode shapes, natural frequencies, structural analysis

A number of programs written over the past few years which calculate the dynamic behavior of structures are described. Some of the programs are involved with the calculation of the mass and stiffness properties of structures; some with the calculation of resonant frequencies and modes and response to the time-dependent forces; and others with the preparation of data and the analysis of results.
AD-711519

71-18

DESCRIPTION AND ANALYSIS OF THE DYNAMICS OF SERVOMECHANISMS WITH THE AID OF MATHEMATICAL MODELS
Zorin, E.V.; Kozlov, O.A.; and Shutkin, L.V.
Wright-Patterson AFB, 22 pp (July 1970)

Key Words: hydraulic systems, mathematical models, pneumatic springs

The dynamics of a hydraulic or pneumatic servosystem (which differ only in their working fluid) are examined. By introducing the concept of hydraulic or pneumatic springs, it is possible to obtain in a convenient form a unified version of the equations of motion of servosystems employing a liquid or a gas as the working fluid. The system equations are linearized with respect to the equilibrium state of the working fluid and are defined by a given relation. The analysis leads to an equation describing a closed-loop servosystem for zero initial conditions which can be written in a given form.
AD-711163

DESIGN INFORMATION
(Also see Nos. 85, 86, 106)

DESIGN TECHNIQUES
(Also see No. 73)

SURVEYS
(Also see No. 53)

71-19

THE VIBRATION MONITOR
Blake, Michael P.
Power Transmission Design 12 (10), 82 (Oct. 1970)

Key Words: vibration monitors

Vibration analyzers are briefly defined, described, and areas of application are discussed. The role of analyzers in fault identification and mass balancing is emphasized.

71-20

THE PRESENT STATE OF THE ART IN THE MEASUREMENT OF SOUND -- PART 2: AUTOMATIC ANALYSIS AND DIGITAL PROCESSING OF ACOUSTIC MEASURING QUANTITIES
Blässer, Heinz
VDI Zeitschrift 112(18), 1222-1227 (1970)

Key Words: acoustic measurement, data reduction, frequency analyzers

The results of a frequency analysis can be used to compute loudness level. In the case of sounds which change with respect to time, real-time analyzers should be employed for the automatic frequency analysis. Electronic data processing equipment serves to reduce the large amount of data obtainable in this fashion. (In German)

71-21

CURRENT STATUS OF RESEARCH ON NONLINEAR PHENOMENA
Melkus, Harald A.
Holloman AFB, 58 pp (June 1970)

Key Words: nonlinear response, reviews

A short review of recent accomplishments in the general area of nonlinear oscillatory phenomena is presented. Scientists from 17 nations met in the USSR (Aug.-Sept. 1969) to exchange ideas on the theoretical background and practical tools available in the analysis of nonlinear processes. Current status, recent progress, and evolving trends are discussed as reflected by the proceedings of this conference.

AD-709870

EXCITATION

ACOUSTIC
(Also see Nos. 20, 47, 52, 63, 64, 67, 81, 82, 90, 95, 110)

71-22

ANALYSIS OF THE FREQUENCY DEPENDENCE OF THE SOUND PRESSURE IN AN ENCLOSURE
Baron, S.B. and Yanpol'skii, A.A.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 163-167 (Oct./Dec. 1970)

Key Words: acoustic measurement, sound transmission, statistical analysis

Premises to the statistical analysis of the frequency dependence of sound pressure in an enclosure are discussed. Fundamental parameters pertinent to the theory of sound amplification and acoustical measurements in an enclosure are calculated. The results of calculations of the analogous parameters of the space fluctuations of the sound pressure are summarized.

71-23

ACOUSTIC WAVES TRANSMITTED THROUGH LIQUID CYLINDERS
Brill, D. and Uberall, Herbert M.
Catholic Univ. Am., 65 pp (Jan. 1970)

Key Words: elastic waves, liquids, wave propagation

The acoustic field of a plane wave incident on an elastic cylinder may be decomposed into two parts: one having the form of circumferential waves propagating around the cylinder; the other obeying the high-frequency limit the laws of geometrical optics. For the simpler case of a liquid cylinder, the geometrical part is studied, and is shown to consist of the specularly reflected wave, and of transmitted waves which traverse the cylinder along a secant, possibly undergoing one or more internal reflections.

71-24

RESPONSE OF A CYLINDER TO RANDOM SOUND IN THE CONTAINED FLUID
Fahy, F.J.
J. Sound and Vibration 13 (2), 171-194 (Oct. 1970)

Key Words: acoustic response, cylindrical shells

Coupled oscillator theory is used to estimate the response of a closed cylindrical shell to broadband sound in the enclosed air. A frequency

is determined above which the response is the same as that to an externally incident, diffuse sound field. It is termed the lower limiting frequency. Below this frequency, the response falls below that produced by external excitation. Two different cylinder and acoustic boundary conditions are investigated experimentally.

71-25

SOUNDPROOFING BY MEANS OF DUCTS WITH CURVED POROUS WALLS
Grigor'yan, F. E.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 192-196 (Oct. /Dec. 1970)

Key Words: acoustic linings, ducts, noise reduction, power plants

The solution of the problem of sound propagation in a curved layered-inhomogeneous medium is applied to the case when certain layers are absorbing. With the aid of numerical-analytic techniques it is shown that under proper conditions the curvature produces a significant increase in the attenuation factor for the fundamental normal mode. The results of the study can be used in the control of noise propagation in the air ducts of power plants, ventilating systems, etc.

71-26

PULSED ULTRASONIC CAVITATION -- PART I: CAVITATION NOISE, LUMINESCENCE THRESHOLDS, NUCLEI DISTRIBUTION
Iernetti, G.
Acustica 23 (4), 189-207 (1970)

Key Words: cavity resonance, fluids

Cavitation is obtained in a 160 cc distilled water sample by pulses of ultrasonic waves. Threshold transducer voltage for sound noise and for luminescence are operationally defined by means of slow cycles of pulse height modulation. The experimentally found sound noise threshold surface $N = N_S(V, \tau)$, and luminescence threshold surface $N = N_L(V, \tau)$ divide the pulse parameter space in three regions: o, $(V, \tau, N_S < N < \infty)$, no cavitation region; s, $(V, \tau, N_L < N < N_S)$, sound noise cavitation region of "stable" cavitation, within the two threshold surfaces; and l, $(V, \tau, 1 \leq N < N_L)$, luminescence cavitation region of "stable" and "transient" cavitation.

71-27

SOUND GENERATION OF A PULSATING EFFUSION PROCESS
Ising, H.
Acustica 23 (3), 142-148 (1970)
Key Words: sound waves

The generation of sound of a periodical effusion process is investigated theoretically and experimentally in a large subsonic velocity region. With increasing critical-velocity ratios the momentum source portion becomes more and more efficient, in addition to the volume source portion. (In German)

71-28

AN INVESTIGATION OF REFLECTION OF ACOUSTIC PULSES FROM SHELLS AND OF SHALLOW WATER SOUND TRANSMISSION
Marshall, Samuel W. and Goodman, Ralph R.
Colo. State Univ., 54 pp (May 1970)

Key Words: shells, sound transmission, water

Approaches to education in acoustics and results stemming from research have been compiled. Research results include the first observation and detailed examination of the Rayleigh type circumferential waves on solid elastic cylinders, calculations to determine the properties of these waves, and a demonstration of the measurement of properties of the sea bottom by shallow acoustic refractions. Most of the details of these results are included.
AD-708571

71-29

PROPAGATION OF JET ENGINE NOISE NEAR A POROUS SURFACE
Oncley, P. B.
J. Sound and Vibration 13 (1), 27-35 (Sept. 1970)

Key Words: aircraft noise, measurement techniques

Acoustic measurements, except those made in anechoic chambers, are often complicated by the characteristics of bounding surfaces. For example, in jet aircraft engine noise measurements, a frequency-dependent pattern of maxima and minima results from interference of direct and reflected waves. When the surface is hard, like concrete, this pattern is readily computed, but over dirt and grass rather puzzling results are often obtained. It is shown that these apparently anomalous effects, sometimes called "ground absorption" or "extra-atmospheric attenuation" can be explained by adding to conventional interference frequency computations the phase delay introduced on near-grazing reflection. This phase delay can be computed after the analysis of Rudnick or Ingard if impedance and propagation constants are known.

PERIODIC

71-30

PERIODIC MOTIONS OF ARBITRARILY LONG PERIODS IN NONLINEAR SPRING-MASS SYSTEMS
Harris, T.C.
Intl. J. Nonlinear Mech. 5(3), 491-500 (Aug. 1970)

Key Words: mass-spring systems, multidegree-of-freedom systems, periodic excitation

The existence of an infinite number of periodic motions of arbitrarily long (minimum) periods is established for idealized spring-mass systems of two and more degrees of freedom. An essential requirement is that the system considered by inherently nonlinear and that the linearized approximation be sufficiently nonresonant.

RANDOM
(Also see Nos. 10, 74)

71-31

THE EFFECT OF ENERGY DISSIPATION IN THE MATERIAL ON THE VIBRATIONS OF AN ELASTIC ELEMENT UNDER RANDOM EXCITATION
Goncharenko, V.M.
Prikladnaya Mekhanika 2(11), 90-96 (1966)

Key Words: cantilever beams, elastic properties, one degree-of-freedom systems, random excitation, structural members, vibration response

The vibrations of an elastic element with one degree-of-freedom under the action of a random steady state Gaussian disturbing force are considered. The hysteresis loss in the material is considered. The method of equivalent linearization and a method based on interpretation of amplitude and phase as Markov processes are employed. The distribution of amplitude probabilities in the steady state and the mean-square reaction of the element are determined.

SHOCK
(Also see Nos. 2, 39, 51, 65, 83, 96)

SELF-EXCITED
(Also see Nos. 7, 70, 93, 107)

71-32

UP-CONVERTER PARAMETRIC AMPLIFICATION OF ACOUSTIC WAVES IN LIQUIDS
Berktay, H.O. and Al-Temimi, C.A.
J. Sound and Vibration 13(1), 67-88 (Sept. 1970)

Key Words: elastic waves, liquids, wave propagation

An experimental investigation of the up-converter type of parametric amplification is reported, together with detailed analyses based upon a simplified model of the field within the interaction volume. The experimental and theoretical investigations are extended to cover briefly the effects resulting from shadowing by the mount of the pump transducer, and those resulting from higher-order interactions at finite pump intensities.

71-33

PARAMETRIC RESPONSE OF NONLINEAR ORTHOTROPIC PLATES
Carter, Willie James
Univ. Ill., 73 pp (1970)

Key Words: orthotropic plates, parametric response, transverse shear deformation

Employing the assumptions of Von Karman, the amplitude and the build-up of amplitude are investigated for an orthotropic elastic plate, subjected to an oscillatory in-plane load. The resulting nonlinear partial differential equations are solved using a modified Galerkin technique. The effect of transverse shear on the boundary frequencies is also investigated.

Univ. Microfilms 70-13, 267
(Ann Arbor, Mich.)

71-34

STABILITY OF DYNAMIC SYSTEMS WITH PERIODICALLY VARYING PARAMETERS
Crimi, Peter
AIAA J. 8(10), 1760-1764 (Oct. 1970)

Key Words: dynamic systems, satellites, stability

A method for analyzing the stability of dynamic systems, which are represented by a coupled set of linear differential equations with periodically varying coefficients, is presented. Results of calculations of the aeroelastic stability

of a helicopter rotor in forward flight are in qualitative agreement with both experimental and numerically derived data.

71-35

AUTOPARAMETRIC VIBRATIONS OF A VIBRATION ISOLATING SYSTEM WITH A NONLINEAR ELASTIC CHARACTERISTIC
Ivovich, V.A.
Prikladnaya Mekhanika 2 (12), 76-81 (1966)

Key Words: parametric response, vibration isolation

An investigation into the parametric interaction of vibrations of a nonlinear vibration isolating system is reported. A condition is found for which natural vibrations along one of the generalized coordinates lead to a parametric excitation of vibrations along another generalized coordinate.

PHENOMENOLOGY

ELASTIC

71-36

VERTICAL VIBRATIONS OF FOOTINGS EMBEDDED IN LAYERED MEDIA
Kuhlemeyer, Roger LeRoy
Univ. Calif., 253 pp (1969)

Key Words: periodic response, finite element technique, footings

A finite element method is developed for steady state vibration analysis of semi-infinite elastic continuous systems. The infinite system is replaced by a finite system subjected to a stress-equilibrium boundary condition; the boundary stress is calculated from elastic wave theory and acts as an energy absorbing mechanism. The finite model was applied to several foundation vibration problems: results compared excellently with existing solutions and new solutions were obtained from embedded footings and for footings on layered media.

Univ. Microfilms 70-13,091
(Ann Arbor, Mich.)

71-37

APPLICATION OF SINGULAR INTEGRAL EQUATIONS TO THE PROBLEM OF FORCED VIBRATIONS OF A RIGID FOUNDATION
Luco, Juan Enrique
Univ. Calif., 94 pp (1969)

Key Words: forced vibration, foundations

A study is presented of the transverse forced oscillations of a rigid infinite strip perfectly bonded to the surface of an elastic half-space. The force-displacement relationships are obtained for vertical, horizontal and rocking vibrations. The problem considered is a dynamic mixed-boundary value problem, in which the displacements are prescribed under the strip while the rest of the surface of the half-space is traction free.

Univ. Microfilms 70-14,304
(Ann Arbor, Mich.)

71-38

HIGHER ORDER ELASTIC CONSTANTS IN PIEZOELECTRIC CRYSTALS IN THE PRESENCE OF ULTRASONIC WAVES
Mathur, S.S. and Gupta, P.N.
Acustica 23 (3), 160-164 (1970)

Key Words: piezoelectric materials, ultrasonic vibration

Expressions for second, third and fourth order elastic constants have been obtained for piezoelectric crystals. The method used is an extension of the treatment given by McMahon for the evaluation of second and third order elastic constants.

71-39

EXACT SOLUTIONS OF SOME DYNAMIC PROBLEMS OF INDENTATION AND TRANSIENT LOADINGS OF AN ELASTIC HALF-SPACE
Thompson, John Carl
Univ. Ill., 250 pp (1969)

Key Words: elastic half-space, transient response

A modified form of the self-similar potential method developed by V. I. Smirnov and S. L. Sobolev is used to solve certain problems which involve the frictionless indentation of a linearly elastic half-space by a rigid die. Solutions, which are exact within the limits of the classical theory of elasticity, are obtained for the early stages of contact for any problem in which the surface of the die is smooth, and for problems in which the die is wedge or conical in shape and indents the half-space at a constant rate. Also included is the general solution of two- and three-dimensional problems which involve transient loads acting at interior or surface points of a homogeneous elastic half-space. The asymptotic character of the disturbance in the vicinity of the wave fronts and the surface wave is investigated for both the two and three-dimensional problems in which the source of disturbance is an impulse acting on the surface of the half-space. For the indentation problem the character of the disturbance near the outer edge of contact is also studied in detail.

Univ. Microfilms 70-13,514
(Ann Arbor, Mich.)

71-40

REFLECTION OF OBLIQUE SHOCK WAVES IN ELASTIC SOLIDS
Wright, Thomas W.
Aberdeen Proving Ground, 70 pp (June 1970)

Key Words: shock waves

The reflection of a finite elastic plane shock wave at a plane boundary is examined. A semi-inverse method of solution is used. Only angles of incidence which are less than a critical angle are considered in detail. A simple existence theorem is stated, critical angle cases are discussed, and several simple examples are presented.
AD-710968

INELASTIC

(Also see Nos. 13, 58, 91)

71-41

SIGNIFICANCE OF STRAIN HARDENING AND STRAIN RATE EFFECTS ON THE TRANSIENT RESPONSE OF ELASTIC-PLASTIC SPHERICAL SHELLS
Duffey, Thomas
Intl. J. Mech. Sci. 12 (9), 811-825 (Sept. 1970)

Key Words: elastoplastic properties, spherical shells, strain hardening, strain rate, transient response

Formulas describing the transient response of uniformly loaded thin spherical shells governed by elastic-plastic material laws are developed. It is assumed that all points in the shell reference surface undergo spherically symmetric motion and that the shell undergoes either fully elastic or fully plastic response at a given time. It is shown that realistic values of linear material strain hardening and linear strain rate sensitivity (rate-dependent yield surface) have a significant effect on both dynamic and final shell deflections.

VISCOELASTIC

71-42

LATERAL VIBRATION OF A NONLINEAR VISCOELASTIC BEAM UNDER INITIAL AXIAL TENSION
Cozzarelli, F.A.; Wu, J.J.; and Tang, S.
J. Sound and Vibration 13 (2), 147-161 (Oct. 1970)

Key Words: beams, lateral vibration, viscoelastic properties

The free lateral vibration of a simply-supported metallic beam under axial creep deformation is considered. The constitutive law is formulated with stress power functions in the primary and secondary creep terms; the instantaneous linear elastic deformation is also included. For better physical visualization, a nonlinear Maxwell-Kelvin model is used to represent the constitutive law. Analytical solutions for the Maxwell-Kelvin model and for the special models are obtained. Numerical results for a stainless steel and an aluminum alloy are also presented and discussed.

COMPOSITE

(Also see Nos. 25, 66, 68, 71)

DAMPING

(Also see Nos. 2, 31, 85, 86)

71-43

FREE AND FORCED OSCILLATIONS OF A DYNAMIC SYSTEM WITH "LINEAR HYSTERETIC DAMPING" (NONLINEAR THEORY)
Caughey, T.K. and Vijayaraghavan, A.
Intl. J. Nonlinear Mech. 5 (3), 533-555 (Aug. 1970)

Key Words: forced vibration, free vibration, hysteretic damping, mathematical models

Using a nonlinear model of "linear hysteretic" damping proposed by Reid, a study is made of the free and forced oscillations of a dynamic system with "linear hysteretic" damping. Ideal solutions are presented for both free and forced oscillations and compared with approximate solutions obtained by the Krylov Bogoliubov Van der Pol method.

FLUID

(Also see Nos. 24, 26, 28, 32, 47, 53, 60, 107)

71-44

HYDROELASTIC VIBRATION OF RODS IN PARALLEL FLOW
Kanazawa, Richard Mazumi
Univ. Ill., 157 pp (1969)

Key Words: fluid-induced excitation, mathematical models, rods

The vibration of rods excited by water flowing parallel to the rod axis is studied both theoretically and experimentally. The theoretical studies present a mathematical model for the

hydroelastic rod and a method for evaluating an equivalent viscous damping coefficient. The analysis assumes that the rod is excited by a random pressure field and, as a consequence, that the rod vibration is random. The experimental studies investigate the rod displacement in fully-developed turbulence and downstream from orifices. The experimental data are processed by using digital methods of random data analysis.

Univ. Microfilms 70-13,372
(Ann Arbor, Mich.)

71-45

EXPERIMENTAL EVALUATION OF DESIGN METHODS FOR HARDENED PIPING SYSTEMS (VOLS. I AND II)
Kot, C.A.; Swatosh, J.J.,Jr.; and Wiedermann, A.H.
Huntsville Corps of Engr., 274 pp (Vol. I), 634 pp (Vol. II), 59 pp (Summary Rept.) (Sept. 1970)

Key Words: computer programs, experimental results, piping

The transient hydraulic pressure loads and pressure losses in simple piping systems and elements caused by transient loads are investigated. Transient pressure loads are applied either to the pipe proper or directly to the fluid within the pipe. A cursory analysis and computational comparison of the experimental data shows that the data can be employed to evaluate the prediction capabilities of present-day computer methods.

71-46

DRAG OF RECTANGULAR CAVITIES IN SUPERSONIC AND TRANSONIC FLOW INCLUDING THE EFFECTS OF CAVITY RESONANCE
McGregor, O. Wayne, and White, Robert A.
AIAA J. 8 (11), 1959-1964 (Nov. 1970)

Key Words: cavity resonance

The drag of short rectangular cavities (length-to-depth ratios of 0.50-3.0) with turbulent shear layers measured at transonic and supersonic Mach numbers (0.3-3.0) is reported. The effect of cavity resonance increases the drag as much as 250 percent. The frequency of the pressure oscillations is best predicted by the vortex-wave interaction model presented by Rositer. The effects of external reinforcement of resonance by reflection of radiated pressure waves are examined. A new model for predicting the lower bound of cavity drag (nonresonating cavity) is presented.

SOIL
(Also see Nos. 85, 86)

EXPERIMENTATION

DIAGNOSTICS
(Also see No. 92)

INSTRUMENTATION
(Also see No. 19)

71-47

VIBRATIONAL MODES OF THIN PIEZOELECTRIC QUARTZ DISKS IN FLUIDS GENERATING ULTRASOUND
Schaaffs, W. and Franz, G.
Acustica 23 (4), 208-213 (1970)

Key Words: disks, fluids, piezoelectric materials, thermal excitation, ultrasonic vibration

When thin piezoelectric quartz disks vibrate in liquids and are radiating ultrasound, the liquid adjacent to the disk is heated according to the amplitude distribution of the vibration. The thermal images of the disks are made visible by using the schlieren technique. The investigation extends to quartz disks of circular contour and also of Straubel type boundary. (In German)

71-48

AMPLITUDE-PHASE HOLOGRAMS OF VIBRATION PATTERNS
Zonkhiev, M.A.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 209-212 (Oct./Dec. 1970)

Key Words: holographic techniques, mode shapes, piezoelectric materials

A method for the preparation of interferometric holograms with numerical evaluation of the amplitudes and phases of the vibrations of individual points of a vibrating body is described. The method is used to determine these parameters for an AC-cut piezoelectric quartz plate at the frequencies of longitudinal, contour, and shear modes

TECHNIQUES

71-49

ON NONLINEAR VIBRATIONS OF LIQUID IN A CYLINDRICAL CAVITY
Anosov, Yu. N.
Prikladnaya Mekhanika 2 (10), 22-28 (1966)

Key Words: experimental results, liquid-containing containers, liquids, nonlinear response

The results of an experimental investigation into the nonlinear vibrations of liquid in a cylindrical cavity are presented. It is shown that the system of equations proposed earlier can be simplified, and the solution of the simplified equation is obtained by the method of small parameters. The experimental method derived for determining the coefficients of the nonlinear terms of the equation is explained, and a quantitative comparison of the test results with the theory is performed.

COMPONENTS

ABSORBERS

71-50

SYNTHESIS AND INVESTIGATION OF LONGITUDINAL-MODE ABSORBERS IN BEAMS AND PLATES
Kashina, V.I.; Tyutekin, V.V.; and Shkvarnikov, A.I.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 213-218 (Oct./Dec. 1970)

Key Words: beams, longitudinal vibration, plates, vibration absorption (equipment), vibration resonance

Some results are given from the synthesis of longitudinal-mode absorbers designed for the attenuation of resonance vibrations in beams and plates. As an example a 10-element optimum absorber operating over a 2-octave frequency range is analyzed. An experimental investigation conducted on a longitudinal-mode absorber yields an energy absorption coefficient of 0.96 to 0.97 in a Duralumin beam 5 mm thick at frequencies from 8 to 32 kc.

71-51

SIDE-SPREADING SPRINGS ABSORB HIGH-ENERGY IMPACT
Swieskowski, Henry P.
Army Weapons Command, 12 pp (Mar. 1970)

Key Words: shock absorbers, springs

The construction and operation of a novel and efficient energy dissipating device are described. Frictional forces that convert kinetic energy to heat are produced by impelling springs that apply pressure between the bronze friction plungers and the housing. A design example with given requirements on absorbed energy, working stroke, and preload is illustrated in a five-step procedure.
AD-711006

CONTROLS
(Also see No. 18)

ISOLATORS
(Also see Nos. 35, 102)

71-52

AN ACOUSTIC REDUCTION TECHNIQUE FOR LOW-FREQUENCY SOUND PROPAGATING IN A WAVEGUIDE
Lapin, A.D.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 233-236 (Oct./Dec. 1970)

Key Words: buildings, noise reduction

A technique is considered for insulation against low-frequency sound propagating in a waveguide by reflection from an elastic plate (or membrane) embedded flush with the wall of the waveguide and tuned to the frequency of the propagating sound.

PIPES
(Also see No. 45)

BEAMS, STRINGS, RODS
(Also see Nos. 1, 16, 42, 44, 50)

71-53

A SURVEY OF INVESTIGATIONS ON THE CONFIGURATION AND MOTION OF CABLE SYSTEMS UNDER HYDRODYNAMIC LOADING
Casarella, Mario J. and Parsons, Michael
Catholic Univ. Am., 18 pp (1970)

Key Words: cables (ropes) hydrodynamic excitation, reviews

A review of the research investigation on the prediction of the motion of a cable system under hydrodynamic loading is presented. Attempts to predict the steady state configuration of a two-dimensional cable have been made since

World War I. Recent studies have included the dynamic response of these systems to external excitation. A discussion of the physical nature of these forces and a survey of existing analytical models for the loading function is included. A comparison with the limited experimental data available is also presented.
AD-710711

71-54

SOLAR INDUCED BENDING VIBRATIONS OF A FLEXIBLE MEMBER
Graham, John D.
AIAA J. 8(11), 2031-2036 (Nov. 1970)

Key Words: flexural vibration, structural members, thermal excitation

The stability of in-plane bending oscillations of long flexible members (STEMs) when subjected to solar heating is examined. The interdependence between the time varying STEM thermal curvature and its bending motion is accounted for in the model.

71-55

ON THE PROBLEM OF SLIGHTLY NONLINEAR THREE-DIMENSIONAL VIBRATIONS OF A BAR
Il'in, R.F. and Kagadii, S.V.
Prikladnaya Mekhanika 2(12), 93-99 (1966)

Key Words: asymptotic series, bars, forced vibrations, method of successive approximations

A combined analysis of the longitudinal, torsional, and transverse three-dimensional forced vibrations of a bar, with energy dissipation in small deformations taken into account, leads to a system of slightly nonlinear differential equations. The solution of this system is given by the method of successive approximations combined with the asymptotic method in the form developed by N. N. Bogolybov and Yu. A. Mitropol'skii.

71-56

NONLINEAR VIBRATIONS OF AN ELASTIC CORD CARRYING CONCENTRATED MASSES
Krasnoshapka, V.A.
Prikladnaya Mekhanika 2(9), 85-92 (1966)

Key Words: flexural vibrations, longitudinal vibrations, strings (structural members)

The equations for the small vibrations of a cord carrying concentrated masses is known to result in the assumption that the stretching of the cord during the vibration is negligibly small in comparison with the value in the equilibrium configuration. The equations of motion of the cord, taking into account the stretching, were derived in an earlier study. However, the motion of the masses parallel to the equilibrium curve was neglected. The equations for the longitudinal-transverse vibrations of a cord carrying concentrated masses is derived. The effects of the nonlinearities on the dynamics of the system are studied.

71-57

TRANSIENT RESPONSE OF FINITE RODS USING THE METHOD OF MODE SUPERPOSITION
Mengi, Y. and McNiven, H.D.
Univ. Calif., 37 pp (Aug. 1970)

Key Words: bars, forced vibration, transient response

The general forced vibration problem of finite, transversely isotropic rods is studied. The specific problem is one of finding the response, expressed as the radial displacement, of an isotropic rod of specified length when a normal force at one end of the rod vibrates at two frequencies: one a resonant frequency of the rod, and one between resonant frequencies.
PB-193941

71-58

A NOTE ON THE NONLINEAR RESPONSE OF AN ELASTIC BEAM ON A FOUNDATION TO A MOVING LOAD
Tang, Sing-Chih and Yen, David H.Y.
Intl. J. Solids Structures 6(11), 1451-1461 (Nov. 1970)

Key Words: beam, elastic properties, moving loads, nonlinear response, perturbation theory

The nonlinear response of an elastic beam to a moving transverse load is studied, using a special perturbation method. Solutions are obtained that remain valid throughout some neighborhood of the critical speed of the linear beam theory. It is found that in general, depending upon the type of dominant nonlinearity in the beam, either the subcritical response or the supercritical response may be continued up to the critical speed and even beyond. The solutions also show how the transitions from a subcritical response to a supercritical response and vice versa take place near the critical speed.

71-59

ON THE NONLINEAR RESPONSE OF AN ELASTIC STRING TO A MOVING LOAD
Yen, David H.Y. and Tank, Sing-Chih
Intl. J. Nonlinear Mech. 5(3), 465-474 (Aug. 1970)

Key Words: elastic properties, moving load, nonlinear response, perturbation theory, strings

The nonlinear response of an elastic string to a moving load is studied, using a special perturbation method. Solutions are obtained that are valid throughout a particular neighborhood of the critical speed of the linear theory.

PLATES AND SHELLS

(Also see Nos, 6, 9, 11, 13, 14, 15, 16, 23, 24, 33, 41, 48, 49)

71-60

SOUND RADIATION FROM TRANSVERSELY VIBRATING FLAT PLATES INTO WATERS
Gulcking, D.; Warhonowicz, Th.; and Buddruss, C.
Acustica 23 (3), 131-141 (1970)

Key Words: flexural vibration, fluids, water, rectangular plates, sound waves

The sound radiation of transversely vibrating flat rectangular plates with and without ribs is measured and compared with a corresponding model. Experimental results are compared with calculations based on a simplified velocity distribution on the plate. The far-field radiation characteristics computed from this distribution by a Fourier transformation are in good agreement with the radiation patterns obtained in a shallow water basin. The total radiated power is measured in a reverberation tank for waterborne sound. The design of this tank is based on a new principle with sound-soft lining. The radiation coefficients measured in model experiments are in good agreement with approximate calculations after Gösele. (In German)

71-61

AXISYMMETRIC VIBRATION OF CONICAL SHELLS
Hartung, R.F. and Loden, W.A.
J. Spacecraft and Rockets 7 (10), 1153-1159 (Oct. 1970)

Key Words: computer programs, conical shells, finite element technique, mode shapes, natural frequencies

The axisymmetric modal properties (frequencies and mode shapes) of thin conical shell frusta are studied to determine how they are influenced by cone length, thickness, apex angle, and boundary conditions. In portions of the frequency spectrum, the cone is observed to vibrate vigorously at the large end, while the small end remains relatively quiescent. Results are obtained using a computer program based on a finite element analysis in which the cone is treated as an assemblage of conical frusta.

71-62

THE NONCLASSICAL THEORY OF FLEXURAL VIBRATIONS IN THICK PLATES
Klyuchnikova, V.G.
Prikladnaya Mekhanika 2 (9), 65-70 (1966)

Key Words: flexural vibrations, method of integrodifferential equations, natural frequencies, plates

The integrodifferential equations derived by Kil'chevskii from the general three-dimensional theory of elasticity without any auxiliary hypotheses or assumptions are used to determine the natural frequencies of plates with free edges. A technique for the solution of integrodifferential equations which combines the collocation method with the method of least squares is presented. Different families of functions approximating the displacements are considered.

71-63

STRUCTURAL RESPONSE TO BOUNDARY LAYER NOISE
Lin, Yung-lo
Princeton Univ. 161 pp (1969)

Key Words: nonlinear theories, plates, turbulence, vibration response

A nonlinear plate theory used to investigate plate vibrational response to the pressure field in a supersonic turbulent boundary layer is described. Contrary to all previous investigations of this problem, the radiation pressure arising from the plate motion is included in the forcing field. The plate displacement is expanded in terms of the modal functions of the plate and Galerkin's procedure is used to reduce the partial stochastic differential equation into a set of nonlinear ordinary stochastic differential equations in time. Both frequency domain and time domain analyses are used to obtain some useful statistical quantities of the plate response.

Univ. Microfilms 70-14,233
(Ann Arbor. Mich.)

71-64

ACOUSTIC RADIATION FROM AN INFINITE PLATE WITH A BAFFLE NORMAL TO ITS SURFACE
Mazzola, Claude J.
J. Sound and Vibration 13 (2), 163-169 (Oct. 1970)

Key Words: method of steepest descent, plates, sound waves

The sound pressure radiated by an infinite plate with a baffle perpendicular to its surface is estimated by the method of steepest descent. Both rigid and pressure-release baffles are considered. The radiation resistance of each type of baffle is also estimated.

71-65

THE INFLUENCE OF ADDED MASS ON THE NATURAL VIBRATIONS AND IMPULSE RESPONSE OF LONG, THIN CYLINDRICAL SHELLS

Palmer, E.W.

Report 3395, Naval Ship Res. Dev. Ctr. (Oct. 1970)

Key Words: cylindrical shells, mode shapes, natural frequencies, shock response

The plane strain solution is obtained for the natural vibrations and impulse response of a thin circular cylinder containing an added line mass. The solution for a uniform cylinder is derived by taking the added mass to be zero. Numerical calculations of the frequencies and mode shapes for several of the lower modes are presented in graphical form for various values of the added mass. The general impulse response solution for arbitrary initial conditions is obtained by normal mode theory.

71-66

THE DYNAMIC RESPONSE OF A SOLID ELASTIC CYLINDER BONDED TO A THIN SHELL

Ruminer, John Jay

Univ. Mich., 97 pp (1969)

Key Words: composite structures, cylinders, transient response

The dynamic interaction of a solid elastic circular cylinder bonded to a thin shell of a different material is studied. The analysis employs linear theory and is restricted to plane strain. Exact dynamical equations of elasticity govern the core. Small deflection thin shell theory, including both membrane and bending effects, governs the shell. The two sets of equations are coupled by the requirement of continuity of surface tractions and displacements at the interface. The free motion of the composite structure and the transient response of the system subject to an arbitrarily prescribed external loading are discussed. Numerical results are presented for different material and loading conditions.

Univ. Microfilms 70-14,627
(Ann Arbor, Mich.)

71-67

SOUND TRANSMISSION THROUGH A PERFORATED PLATE OF FINITE THICKNESS

Shenderov, E. L.

Soviet Physics - Accustics (Translation of Akusticheskii Zhurnal) 16 (2), 244-249 (Oct./Dec. 1970)

Key Words: plates, sound transmission

The problem of sound transmission through a perforated absolutely rigid plate of arbitrary wave thickness is solved. The solution is reduced to an infinite set of linear algebraic equations. Simple approximate expressions are derived for calculating the sound transmission coefficient through a plate with circular or rectangular holes, in the case of arbitrary plate thickness, and holes of small diameter relative to the sound wavelength. It is shown that at certain frequencies the fluid columns in the holes acquire resonances, in which case total sound transmission through the plate occurs. In a number of cases, due to the increase of the radiation impedance of the holes (coincidence resonance) a reduction occurs in the transmission coefficient. Some analytical graphs are presented.

71-68

BENDING, VIBRATION AND BUCKLING OF SIMPLY SUPPORTED THICK ORTHOTROPIC RECTANGULAR PLATES AND LAMINATES

Srinivas, S. and Rao, A.K.

Intl. J. Solids Structures 6 (11), 1463-1481 (Nov. 1970)

Key Words: free vibration, plates, rectangular plates

A unified exact analysis for the statics and dynamics of a class of thick laminates is presented. A three-dimensional, linear, small deformation theory of elasticity solution is developed for the bending, vibration and buckling of simply-supported thick orthotropic rectangular plates and laminates. All the nine elastic constants of orthotropy are taken into account. The solution is formally exact and leads to simple infinite series for stresses and displacements in flexure, forced vibration and "beam-column" type problems, and to closed form characteristic equations for free vibration and buckling problems.

71-69

NATURAL VIBRATIONS OF ORTHOTROPIC PLATES

Tret'yak, V.G.

Prikladnaya Mekhanika 2 (9), 44-52 (1966)

Key Words: mode shapes, natural vibrations, orthotropic plates, variational methods

The influence of boundary conditions on the frequency of natural vibrations of orthotropic plates is studied. The modal shape and frequency are found by means of a variational technique involving successive approximations and the determination of the roots of transcendental equations on a computer. The results are given in tables and graphs. The linearized formulation of the problem is used.

71-70

COMPARISON OF THEORY AND EXPERIMENT FOR NONLINEAR FLUTTER OF LOADED PLATES
Ventres, C. S. and Dowell, E. H.
AIAA J. 8 (11), 2022-2030 (Nov. 1970)

Key Words: experimental results, flutter, nonlinear response, plates, theoretical analysis

The flutter behavior of clamped plates exposed to transverse pressure loadings, or buckled by uniform thermal expansion is investigated. Quasi-steady aerodynamic theory and von Kármán's plate equations are employed. Zero in-plane motion normal to the edges, and zero in-plane stress at the edges are considered. Nonlinear ordinary differential equations are obtained by using a modal expansion of the transverse deflection in conjunction with Galerkin's method. These are integrated numerically to determine the flutter motion.

71-71

FREE VIBRATIONS OF ORTHOTROPIC SANDWICH CONICAL SHELLS WITH VARIOUS BOUNDARY CONDITIONS
Wilkins, D.J., Jr.; Bert, C.W.; and Egle, D.M.
J. Sound and Vibration 13 (2), 211-228 (Oct. 1970)

Key Words: composite structures, conical shells, cylindrical shells, free vibrations, Galerkin method

An analysis of axisymmetric and unsymmetric free vibrations of conical or cylindrical shells with various boundary conditions is presented. The shell construction considered is either homogeneous or symmetrical sandwich, and the facing and core is either isotropic or specially orthotropic. Love's first-approximation shell theory, with transverse shear strain added is used and solutions are obtained by Galerkin's method. Comparisons are made with existing experimental results for the following boundary conditions: freely supported at both ends; clamped-clamped; and free-free.

PANELS
(Also see No. 7)

71-72

DISCRETE ELEMENT APPROACH TO FLUTTER OF SKEW PANELS WITH IN-PLANE FORCES UNDER YAWED SUPERSONIC FLOW
Kariappa, B.R.S. and Shah, C.G.
AIAA J. 8 (11), 2017-2021 (Nov. 1970)

Key Words: flutter, skew plates, ultrasonic vibration

Matrix displacement methods are applied to the flutter problem of skew panels with in-plane forces under yawed supersonic flow. Kinematically consistent aerodynamic influence coefficient matrices are employed in the formulation of the dynamic equations of motion.

71-73

AN APPROXIMATE METHOD FOR THE DETERMINATION OF THE NATURAL FREQUENCIES OF SINGLE AND STIFFENED PANEL STRUCTURES
Szechenyi, Edmond
Southampton Univ. (England), 31 pp (Mar. 1970)

Key Words: approximations, natural frequencies, numerical analysis, panels, plates

Simple formulae are found which predict the resonant frequencies of various common panel structures. Clamped plates and conventionally and integrally stiffened panels are considered.
AD-708474

71-74

CALCULATION OF THE RANDOM VIBRATION CHARACTERISTICS OF A PANEL IN THE SOUND FIELD OF AN EXHAUST JET
Valeev, K.G. and Kvitka, V.E.
Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal) 16 (2), 184-186 (Oct./Dec. 1970)

Key Words: acoustic excitation, panels, plates (structural members), random response

An approximate technique is described for calculating the probabilistic characteristics of the stresses involved in the vibration of flat panels in the sound field of a jet engine exhaust. The spectral density of the acoustic load is determined experimentally from the frequency spectra of the sound pressure. The results of the calculations are verified experimentally.

GEARS

71-75

THE INFLUENCE OF AXIAL VIBRATIONS UPON THE ENERGY LOSSES AND EFFICIENCY OF SPUR GEAR SYSTEMS
Mamoun, Michael Mounir
Univ. Ill., 299 pp (1969)

Key Words: axial force, gears

The influence of an axial vibrational motion upon the frictional energy losses and the efficiency of a spur gear system is analytically and experimentally determined. A theory is developed that explains the influence of axial vibrations upon the frictional forces arising from the sliding of the engaging gear teeth, and also reveals the effects of a two-dimensional motion or axial vibrations on the frictional forces between any two contacting surfaces. Based upon this theory, some mathematical expressions are derived for the frictional energy losses and the efficiency of a spur gear system subjected to axial vibrations.

Univ. Microfilms 70-13,406
(Ann Arbor, Mich.)

SYSTEMS

MECHANICAL

(Also see No. 14)

STRUCTURAL

(Also see Nos. 17, 19)

71-76

A PROCEDURE FOR THE DYNAMIC ANALYSIS OF THIN WALLED CYLINDRICAL LIQUID STORAGE TANKS SUBJECTED TO LATERAL GROUND MOTIONS
Edwards, Norman Wayne
Univ. Mich., 174 pp (1969)

Key Words: dynamic response, lumped mass method, seismic exc tation tanks (containers)

Dynamic responses of elastic, thin walled, cylindrical, flat bottom, liquid storage tanks subjected to arbitrary lateral ground motions are investigated.

Univ. Microfilms 70-14,507
(Ann Arbor, Mich.)

71-77

EARTHQUAKE RESPONSE OF CONCRETE GRAVITY DAMS
Chopra, Anil K.
Univ. Calif., 40 pp (Jan. 1970)

Key Words: dams, interaction: structure-medium, seismic response

An investigation of the response of concrete gravity dams to horizontal earthquake excitation is reported. Reservoir interaction effects are included and the errors that may be introduced by common simplifying assumptions, such as neglecting interaction effects and compressibility of water, are evaluated.
AD-709640

71-78

DYNAMIC STRESS ANALYSIS OF AXISYMMETRIC STRUCTURES UNDER ARBITRARY LOADING
Ghosh, Sukumar
Univ. Calif., 124 pp (1969)

Key Words: finite element technique, interaction: structure-medium, nuclear power plants, pressure vessels, seismic excitation, shells

A finite element method is presented for the dynamic analysis of complex axisymmetric structures subjected to any arbitrary static or dynamic loading or base acceleration. This method of analysis is applied to various practical cases like nuclear reactor containment pressure vessels, the response of tubes to moving pressure, etc. Structure-foundation interaction effects are also investigated.

Univ. Microfilms 70-13,054
(Ann Arbor, Mich.)

71-79

PARAMETRIC STUDY OF NATURAL FREQUENCIES OF SKIN-STRINGER STRUCTURE
McDaniel, T. J.
Univ. Ohio, 90 pp (July 1970)

Key Words: aircraft, beams, natural frequencies, skin-stringer method

The results of a parametric study of the natural frequencies of a row of skin-stringer structures are reported. Typical aircraft structures with Z-section, or milled stringers are considered. The effect on the natural frequencies of parametric variation of stringer spacing, distance between frames, thickness of the covering skin, and material properties of the structure are tabulated.
AD-711383

71-80

AN AUTOMATIC COMPUTATIONAL PROCEDURE FOR CALCULATING NATURAL FREQUENCIES OF SKELETAL STRUCTURES
Williams, F.W. and Wittrick, W.H.
Intl. J. Mech. Sci. 12 (9), 781-791 (Sept. 1970)

Key Words: dynamic stiffness, framed structure, matrix methods, natural frequencies

A method for finding all required natural frequencies of undamped vibration of linearly elastic skeletal structures, when the members are analyzed as continuous and uniform, using dynamic stiffnesses, and not as an approximately equivalent lumped-mass system is described. The method is developed explicitly for rigidly jointed plane frames, but space frames, grillages, etc. can be included without extension of the principles.

ACOUSTIC ISOLATION

71-81

SOUND MEASUREMENTS ON BUILDING MACHINES
Rathe, E.J.
Acustica 23 (3), 149-155 (1970)

Key Words: machinery, measurement techniques, noise measurement, noise reduction

The noise of more than 200 machines used in building and road construction work measured under uniform conditions is reported. The results show the distribution of levels for various types of machine. In some cases, simple noise reduction measures are evaluated. (In German)

AIRCRAFT

71-82

MEASUREMENTS OF THE RADIATED NOISE FROM SAILPLANES
Smith, D.L.; Paxson, R.P.; Talmadge, R.D.; and Hotz, E.R.
Wright-Patterson AFB, 115 pp (July 1970)

Key Words: aerodynamic excitation, aircraft noise, noise measurement

Measurements taken of the noise radiated from three sailplanes in order to define the aerodynamic noise and determine its relation to aircraft size and velocity are presented. Results obtained from one microphone are given and the overall sound pressure level is related to the aircraft parameters.
AD-709689

BUILDING

(Also see No. 84)

71-83

THE INELASTIC BEHAVIOR OF MULTI-STORY BRACED FRAME STRUCTURES SUBJECTED TO EARTHQUAKE EXCITATION
Workman, George Henry
Univ. Mich., 172 pp (1969)

Key Words: elastoplastic properties, framed structures, multistory buildings, nonlinear response, seismic excitation

The nonlinear response of a 10-story, single-bay braced frame steel structure with elastoplastic member behavior is studied under conditions of dynamic loading. The dynamic loading used is 1-1/2 times the North-South component of the El Centro, California earthquake (May 18, 1940). The structure is idealized by a series of equivalent masses, lumped at the floor levels and restrained by weightless members.
Univ. Microfilms 70-14,686
(Ann Arbor, Mich.)

BRIDGES

(Also see No. 53)

EARTH

(Also see Nos. 77, 83, 109)

71-84

EARTHQUAKE ISOLATION OF MULTISTORY CONCRETE STRUCTURES
Caspe, Marc S.
J. Am. Concrete Inst. 67 (11), 923-933 (Nov. 1970)

Key Words: multistory buildings, seismic design, vibration isolation

A new concept is introduced for the protection of multistory concrete structures from the effects of earthquake ground motions. The concept is an isolation technique in that the superstructure is effectively insulated from the ground vibrations.

71-85

SHEAR MODULUS AND DAMPING IN SOILS -- PART I: MEASUREMENT AND PARAMETER EFFECTS
Hardin, Bobby O. and Drnevich, Vincent P.
Univ. Ky., 52 pp (July 1970)

Key Words: material damping, measurement techniques, measuring instruments, seismic excitation, shear modulus, soils

Apparatus used to measure shear modulus and damping in soils must be capable of making accurate measurements at very small shearing strains, the range being defined by practical problems in earthquake and foundation vibrations. Based on numerous tests on a spectrum of disturbed and undisturbed soils, the shear modulus decreases and the damping ratio increases very rapidly with increasing strain amplitude. The rate of increase or decrease depends on many parameters, the most important of which are: effective mean principal stress, degree of saturation, void ratio, and number of cycles of loading. A pseudostatic simple shear apparatus and two different resonant column apparatus used in this study are described.
PB-193607

71-86

SHEAR MODULUS AND DAMPING IN SOILS -- PART II: DESIGN EQUATIONS AND CURVES
Hardin, Bobby O. and Drnevich, Vincent P.
Univ. Ky., 56 pp (July 1970)

Key Words: graphic methods, material damping, shear modulus, soils

Equations and graphs for the determination of shear modulus and damping in soils for use in design problems involving repeated loading or vibration of soils are presented. These are based on numerous laboratory tests on both remolded and undisturbed cohesive soils and on clean sands.
PB-193608

71-87

ANALYSIS OF THE RESPONSE OF EARTH DAMS TO EARTHQUAKES
Mathur, Jagdish Narain
Univ. Calif., 185 pp (1969)

Key Words: dams, seismic response

A procedure using the shear slice approach is proposed to incorporate strain dependent shear moduli and damping ratios in the response analysis of earth dams on rigid bases. Two problems are considered: (1) the influence of strain dependent shear moduli and damping ratios of soils on the results of analyses of the seismic response of earth dams resting on rigid foundations; and (2) the determination of the seismic response of dams resting on flexible foundations and in particular, the ascertainment of significant parameters affecting the dam foundation interaction.
Univ. Microfilms 70-13,116
(Ann Arbor, Mich.)

71-88

EARTHQUAKE RESPONSE OF ARCH DAMS
Tahbildar, Umesh Chandra and Tottenham, Hugh
J. Struc. Div., Proc. ASCE 96 (ST11), 2321-2336 (Nov. 1970)

Key Words: dams, finite element techniques, seismic response, shells

A theoretical assessment of the dynamic response of arch dams to earthquakes is made using the finite element shell formulation. The results reveal that seismic forces can induce high tensile stresses in arch dams and therefore these forces should be given serious consideration in design. The response for a particular dam (Type 5, specified by the Institution of Civil Engineers, England) is obtained for three earthquakes: El Centro, May 18, 1940, N-S; Santa Barbara, June 30, 1941, N45E, and Taft, July 21, 1952, S69E.

ENVIRONMENTS
(Also see Nos. 76, 94)

71-89

AN ANALYSIS OF THE VIBRATION ENVIRONMENT AT NORTHROP'S NORWOOD, MASSACHUSETTS TEST FACILITY WITH APPLICATION TO GYRO TESTING
Crowley, Francis A.: Ossing, Henry A.: and Hogan, John G.
L.G. Hanscom Field, 49 pp (July 1970)

Key Words: seismic excitation, test facilities

Seismic measurements taken at Northrop's inertial test facility, Norwood, Massachusetts, are described. The purpose of these measurements and subsequent analyses is to characterize the motion environment of the test facility in terms relevant to facility design and guidance component performance tests.
AD-710609

71-90

NOISE ENVIRONMENTS WITHIN MULTIPLACE FIXED-WING AIRCRAFT
Gasaway, Donald C.
Brooks AFB, 22 pp (May 1970)

Key Words: aircraft noise, human factors engineering, test data, turbomachinery

Acoustic environments sampled at different locations within eight groups of fixed-wing aircraft during conditions of normal cruise are defined. A total of 51 aircraft, representative of vehicles powered by reciprocating, turbopropeller, and turbojet or turbofan engines, provide the data from which 28 noise envelopes are plotted.
AD-708430

FRAMES
(Also see Nos. 3, 4)

71-91

DYNAMIC SNAP-THROUGH OF AN ELASTIC-PLASTIC SHALLOW CIRCULAR ARCH
Fisher, Harold Donald
Univ. Mich., 72 pp (1969)

Key Words: arches, dynamic response, elastoplastic properties

The dynamic snap-through of a shallow circular arch subjected to radial impulses of sufficient magnitude to cause nearly instantaneous, compressive plastic flow is investigated. The arch is composed of an elastic-linear strain hardening material. Constitutive equations for the membrane stress resultant and bending moment corresponding to each segment of the stress-strain curve are formulated. The strain-displacement relations and the equation of motion in the radial direction are used to study the initial and long-term response of the arch.
Univ. Microfilms 70-14,517
(Ann Arbor, Mich.)

HELICOPTERS

71-92

ROTOR/WING
Briardy, F.J.; LaForge, S.V.; and Neff, J.R.
Hughes Tool Co., 79 pp (Mar. 1970)

Key Words: aerodynamic characteristics, dynamic tests, rotary wings

The technical status of the rotor/wing concept of a stopped-rotor helicopter configuration is presented. The configuration presents attractive performance characteristics for a high-speed VTOL aircraft. The ability to predict aerodynamic performance characteristics in all flight modes is substantiated by wind-tunnel tests. A major technical problem of 3-per-rev oscillating loads on the rotor/wing pylon was minimized by the effective use of cyclic blade pitch during the high advance-ratio portion of conversion.
AD-710425

METAL WORKING AND FORMING

71-93

GENERATION AND GROWING UP PROCESS OF SELF-EXCITED CHATTER VIBRATION IN GRINDING
Shiozaki, Susumu; Miyashita, Masakazu; and Furukawa, Yuji
Bull. Japan Soc. Mech. Engrs. 13 (63), 1139-1150 (Sept. 1970)

Key Words: chatter, machinery, self-excited vibration, vibration response

The stability criterion for the grinding system is analyzed using the frequency response method. It is shown: (1) that even the system in the unstable region, according to the old stability criterion, is stable at the beginning of grinding until the primary waviness coincident with the chatter frequency is formed to a certain level by disturbance; (2) that the waviness growing up process revealed by translating the system from the frequency domain to the time domain can be described by a series of the rates of dynamic cutting residue; and (3) that the vibration is kept to a steady amplitude if it grows up to the level where the regenerative effect decreases due to a noncontact of the wheel with work.

PACKAGE

71-94

AIRBLAST LOADING OF A LARGE METAL SHIPPING CONTAINER: LABORATORY INVESTIGATION
Carre, Gary L. and Walker, Robert E.
Waterways Experiment Station, 59 pp (July 1970)

Key Words: containers, dynamic testing, nuclear explosions

A program conducted to determine if a large metal shipping container would provide a sufficient degree of protection from simulated nuclear weapon blast effects to make it suitable as a small protective shelter is reported. Two instrumented containers subjected to blast loads are described.
AD-710961

PUMPS AND TURBINES

71-95

EXPERIMENTAL STUDIES OF DISCRETE TONE NOISE FROM AN AXIAL FLOW FAN
Chandrashekhara, N.
J. Sound and Vibration 13 (1), 43-49 (Sept. 1970)

Key Words: acoustic measurements, blades, experimental results

Some measurements of discrete tone radiation from an axial flow fan are presented in the form of tone directivity. These are explained from established theory. The effect of cutoff is explained and the measured discrete tone power at blade passing frequency and harmonics are presented. These are compared with the radiation efficiency of corresponding modes.

71-96

BLAST RESISTANT FANS FOR HARDENED COOLING TOWERS
Chapler, R.S. and Pal, D.
Port Hueneme Naval Civil Engr. Lab., 45 pp (June 1970)

Key Words: blast resistant design, cooling towers, fans

The nuclear blast resistant characteristics of vane axial and centrifugal type fans used on cooling towers are studied. A 12 in. compressed air driven shock tube was used in the experimental program.
AD-710740

RAIL

71-97

DYNAMIC ANALYSIS OF MULTIPLE CAR VEHICLES USING COMPONENT MODES (VOLUME I: ANALYSIS)
Hasselman, T.K.; Riead, H.D.; and Kaplan, A.
TRW Systems, 271 pp (July 1970)

Key Words: component mode synthesis, computer programs, dynamic analysis, railroad trains

The development of a computer program to predict the dynamic characteristics of multiple car trains is documented. Analysis by subsystems forms the basis of the study, followed by application of the method of component mode synthesis to obtain an accurate approximate solution with a reduced number of coordinates, and thus reduced computing time.
PB-193545

71-98

DYNAMICS OF INDEPENDENTLY ROTATING WHEEL SYSTEMS
Kaplan, A. and Short, S.A.
TRW Systems, 74 pp (July 1970)

Key Words: high speed transportation, human factors engineering, hunting, transportation systems, tube vehicle systems

An analysis of the dynamics of individually rotating wheel systems for use on high-speed rail systems such as the Tube Vehicle System is presented. The analysis indicates that the use of independently rotating wheel systems eliminates the standard hunting instability, but it introduces a lightly damped but stable oscillation of its own. However, by increasing the yaw stiffness, the frequency of this oscillation can be moved beyond the low point in the human vibration tolerance limit. When this is done, the ride response is improved over that for a conventional integral wheel system.
PB-194000

71-99

STUDIES FOR RAIL VEHICLE TRACK STRUCTURES
Meacham, H.C.; Prause, R.H.; Ahlbeck, D.R.; and Kasuba, J.A.
Battelle Memorial Inst., 208 pp (Apr. 1970)

Key Words: computer programs, interaction: rail-wheel

Conventional (tie-type) and nonconventional rail vehicle track structures are investigated. The restriction that standard gage and rail-head contour be used is imposed. Computer programs are used to analyze track response to both static and dynamic vehicle loading. The models of conventional track were validated by track, and on the Penn-Central high-speed track near Bowie, Maryland. The DOT research cars were used to obtain a series of controlled-speed passes at speeds up to 125 mph. Track response under Metroliner and regular freight traffic was also recorded, both at a joint and away from a joint.
PB-194139

71-100

DYNAMIC RESPONSE OF CONTINUOUS BEAM ELEVATED GUIDEWAYS (VOLUME I: ANALYSIS
Lipner, N.; Evensen, D.A.; and Kaplan A.
TRW Systems, 104 pp (July 1970)

Key Words: computer programs, dynamic response, railroad trains

A train-elevated guideway interaction program is described. A two-vehicle train traveling at constant velocity over a series of uniform, simply-supported, continuous span bridges, is considered. A technique for considering non-uniform guideway beams is developed and discussed. The equations governing the train and guideway responses are numerically integrated from arbitrary initial conditions. The bridges can have initial camber or roadway roughness conditions. As part of the program formulations, the dynamic response of a semi-infinite uniform and periodically supported beam load by end moments is derived. The program calculates motion parameters, wheel loads, and bending moments in the spans as a function of time.
PB-194137

71-101

DYNAMIC RESPONSE OF CONTINUOUS BEAM ELEVATED GUIDEWAYS (VOLUME II: COMPUTER PROGRAM)
Roberts, F.B.; Lipner, N.; Evensen, D.A. and Kaplan, A.
TRW Systems, 172 pp (July 1970)

Key Words: computer programs, dynamic response, railroad trains

This volume of the train-elevated guideway interaction program contains the computer program. The analysis is provided in Volume I.
PB-194138

ROAD

71-102

ELASTOMERS ASSUME MAIN ROLE IN TRUCK AND TRAILER SUSPENSIONS
Flanagan, William
Automotive Engr. 78(12), 34-37 (Dec. 1970)

Key Words: elastomers, suspension systems (vehicles)

Elastomers are no longer limited to secondary use for isolators. Rubber is becoming more popular as the main spring element because of the advantages of inherent damping and variable spring rates. Basic background is presented.

ROTORS

71-103

AERONAUTIC NAVIGATION EQUIPMENT
Pavlovskii, M.A.; Demidenko, V.P.; Myachin, V.E.; Lopatin, V.I.; and Delektorskii, B.A.
Joint Pub. Res. Ser., 81 pp (Aug. 26, 1970)

Key Words: balancing, gyroscopes, instrumentation

Navigational aeronautic equipment is investigated. Instrumental errors of gyroscopes, the dynamic balancing of rotors, and special problems of specific equipment operating under various conditions are studied.

71-104

DYNAMICS OF DISTRIBUTED PARAMETER ROTOR SYSTEMS: TRANSFER MATRIX AND FINITE ELEMENT TECHNIQUES
Ruhl, Roland Luther
Cornell Univ., 335 pp (1970)

Key Words: distributed parameter method, finite element techniques, periodic response, rotors, stability, transfer matrix method

The dynamics (stability and steady state unbalance response) of distributed parameter rotor systems are investigated by both transfer matrix and finite element techniques.

Univ. Microfilms 70-12,646
(Ann Arbor, Mich.)

SPACECRAFT

71-105

DYNAMIC STABILITY OF A SATELLITE WITH AN ELASTIC MEMBRANE
Brown, Donald Paul
Univ. Wis., 98 pp (1969)

Key Words: dynamic stability, dynamic systems, mathematical models, satellites

A mathematical model of a satellite with continuous elastic components is defined as consisting of a moment free rigid carrier to which is attached an elastic membrane. The membrane is oriented such that a centroidal principal axis of the rigid carrier is normal to the undeflected membrane and passes through the membrane center of mass. The system is considered to be conservative.

Univ. Microfilms 70-3427
(Ann Arbor, Mich.)

TURBOMACHINERY

71-106

A STUDY OF RESONANCE COINCIDENCE IN BLADED DISKS
Ewins, D.J.
J. Mech. Engr. Sci. 12(5), 305-311 (Oct. 1970)

Key Words: fatigue life, turbine blades, turbomachinery, vibration resonance

The failure in service of just one or two out of a batch of nominally identical units poses the problem of establishing the immediate cause and importance of the failures. The significance of the failure is examined in relation to the vibration loads borne by turbomachinery blading. The possibility that minor dimensional variations between one unit and another can result in them exhibiting significantly different vibration characteristics is studied in two detailed cases.

71-107

RESEARCH ON THE FLUTTER OF AXIAL-TURBOMACHINE BLADING
Sisto, Fernando and Ni, Ron Ho
Stevens Inst. Tech., 39 pp (June 1970)

Key Words: blades, flutter, turbomachinery

Theoretical and experimental phases of a program to study flutter in turbomachinery blading are summarized. The analytical model serves mainly to describe the unstalled, linearized baseline from which the large amplitude, possibly stalled data may be compared. The effect of significant parameters on quasi-static aerodynamic moment is displayed and generalized conclusions are drawn.
AD-710794

USEFUL APPLICATION

71-108

PILE DRIVING BY MEANS OF LONGITUDINAL AND TORSIONAL VIBRATIONS
Kovacs, Austin and Michitti, Frank
Cold Regions Res. Engr. Lab., 23 pp (July 1970)

Key Words: pile driving, resonant frequency, vibrators (machinery)

Vibratory pile driving is discussed with particular emphasis on pile driving at resonance where maximum driving efficiency can be expected. The theories and concepts associated with longitudinal and torsional pile driving are presented to show that torsional resonance does not appear to be as effective a method as longitudinal resonance and that considerable variations can exist between calculated and observed resonant frequencies. While it is pointed out that equations by Bernhard and Kovacs predict pile resonance in close agreement with that observed during actual pile driving, it is also suggested that these equations be subjected to a more rigorous evaluation to determine whether they can predict the resonant frequency of all force generator-column systems.
AD-711533

71-109

THE PERFORMANCE OF A STOTHERT AND PITT VIBROLL T20C 12Mg TOWED VIBRATING ROLLER IN THE COMPACTION OF SOIL
Toombs, A. F.
Road Res. Lab. (England), 20 pp (1970)

Key Words: compacting, soils, vibrators (machinery)

An investigation into the performance of a Vibroll T208 12 Mg towed vibrating roller in soil compaction is reported. The equipment was used with the following soils: a heavy clay, a sandy clay, a well-graded sand, a gravel-sand-clay, and a uniformly graded fine sand.
PB-194135

71-110

DEVELOPMENT OF AN ULTRASONIC GUIDE FOR THE INSPECTION OF BUTT WELDS IN COMMERCIAL SHIPS
Youshaw, Robert A.
White Oak Naval Ordnance Lab., 49 pp (May 1 1970)

Key Words: ships, testing techniques, ultrasonic tests

Technical considerations involved in preparing a guide for the ultrasonic inspection of butt welds in commercial ships are documented. The acceptance criteria for the ultrasonic inspection method closely approximates those of the radiographic method in the previously published Ship Structure Document SSC-177-Guide for Interpretation of Nondestructive Tests of Welds in Ship Hull Structures.
AD-709918

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BOOKS

THE PHYSICAL BASIS OF METAL FATIGUE
P. J. E. Forsyth
American Elsevier Publishing Company, Inc.,
New York, N.Y. (1969)

Many engineers assume that little is known about the fundamental mechanisms that affect fatigue of metals. This book summarizes in concise form the extensive present-day knowledge of the microscopic changes that occur in the crystallographic structure in terms understandable to the engineer. Forsyth has done an excellent job of correlating the wealth of valuable data on fundamental fatigue processes as observed by the metallurgist; these are interpreted in terms of the behavior of commercial metals.

The book develops the subject logically from the crystal structure and metal deformations to crack initiation processes. The stages of crack growth are examined and related to appearances of service fractures. Detailed mechanisms are related to the influence of environmental effects such as temperature, frequency, simultaneous corrosion and fretting fatigue. The later chapters discuss factors leading to scatter in life, influence of residual stresses and practical implications of notches, welding, overstressing, etc. This book will not serve as a handbook to the routine designer, but as a valuable source of better understanding of the nature of progressive fracture. The engineer and metallurgist interested in research and development of mechanical equipment will find the concepts of great importance in avoiding troublesome fatigue failures.

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AIRCRAFT VIBRATION AND FLUTTER
Robert H. Scanlan and Robert Rosenbaum
Dover Publications, Inc.,
New York, N.Y. (1968)

This is a paperback reprint of a book which was originally published in 1951 by the Macmillan Company. It is of particular interest to the reviewer, who obtained a copy when it was first published, and used it to learn the flutter business. The book was aimed at two types of readers, the practicing engineer, and the student requiring a senior or graduate level textbook. As might be expected, it does not cover unsteady lifting surface theory, which has been developed in the late fifties and sixties, nor does it reflect the considerable impact of high speed computers on numerical methods. However, it still serves as an excellent introductory text, and would meet the requirements for a one semester introductory course admirably.

The elastic aircraft is treated by expressing the Lagrangian equations of motion, in which the normal modes of vibration are used as generalized coordinates. This remains, to this day, the principal method of handling the flutter problem, but was relatively new when the book was first published. Also, extensive use is made of matrix notation, again relatively new when applied to this extent, even though the text Elementary Matrices by Collar, Duncan, and Frazer had emphasized the flutter problem when it appeared in 1946. It is this use of matrix notation which makes the text particularly valuable as an introduction.

So-called "three-dimensional" flutter theory is discussed. However, this refers to the use of spanwise integration of the generalized forces acting on each of the coordinates, as opposed to the cruder method of selecting a representative wing station at which to apply all of the aerodynamic forces. The aerodynamics remain strictly two-dimensional, in fact, the method used is frequently referred to as "strip theory." Emphasis is mainly on subsonic incompressible flow, although tables are given for supersonic flow. Tables for subsonic compressible flow have appeared in the literature more recently, and can be used readily in the analytical method described.

The method of vibration analysis treated in the book is the familiar mass and influence matrix method. Levy's method of obtaining structural influence coefficients is described. This is of particular historical interest because it was a first step in the development of present-day finite element methods. In summary, this is a welcome edition which might well be around for many years to come.

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STANDARD PROBE HYDROPHONE FOR ACOUSTIC MEASUREMENTS FROM 10 Hz to 200 kHz
Groves, I.D., Jr. and Tims, A.C.
J. Acoust. Soc. Am. 48(3), 725-728 (1970)
Refer to Abstract 70-721

I never cease to be amazed by the technical advances associated with the development of piezoelectric-element hydrophones. Ever since Langevin gave impetus to the whole business circa 1918 with a submerged quartz crystal, hydrophones have gone through many improvements, notably at the Navy's Underwater Sound Reference Laboratory in Orlando, Florida.

The subject paper discusses the construction and dynamic response of one of the more recent small hydrophones with overall dimensions of approximately 1.45 cm diam by 15.4 cm long. This probe-type hydrophone was developed for making point-to-point SPL measurements in the nearfield of sources such as sonar transducers, acoustic arrays, etc. Such probes must be small in order to measure high frequency fields, since their characteristic sizes must be small compared to the wavelengths associated with the propagating waves. This implies the use of a small sensing element. However, use of too small an element results in insufficient sensitivity. Compromise eventually dictates size.

In view of the information in the paper, the present probe possesses those features deemed necessary for a reliable piezoelectric-element hydrophone, namely: stability, low electrical impedance and good sensitivity. However, the hydrophone has some additional features of interest. For example, the sensing element is electrically shielded by a screen fabricated from a 0.05-mm thick flattened, expanded metal sheet. It also has an FET transistorized preamplifier built into the cable end of the butyl-sheathed device. With the sensing element supported softly in a small, circular rubber disk, the problem of noise in the form of structure-borne interference is greatly alleviated. This is always a problem and, at that, a significant one, inherent in the development of small sensing probes.

The performance of the hydrophone is also impressive. With a sensitivity of -120 dB re 1 v/μBar and an output impedance of 100 Ω, the probe has a flat response from 10 to 60 kHz with an ensuing falloff in sensitivity to 200 kHz. The wide frequency range of applicability of the probe is due to the natural resonances of the sensitive element which occur well above 300 kHz. Then too, the maximum sound pressure levels at which 1 percent distortion occurs, in conjunction with a low noise level, results in a probe which has an excellent dynamic range.

This latest hydrophone should prove to be an excellend standard. Moreover, it should be extremely useful for measuring the sound fields of underwater acoustic sources. Its size and characteristics will make it easy to handle and apply to the measurement of other liquid systems where pressure fluctuations predominate.

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THE RESPONSE AND ACOUSTIC RADIATION OF PANELS EXCITED BY TURBULENT BOUNDARY LAYERS
Szechenyi, E.
Wright-Patterson AFB, AFFDL-TR-70-94, 171 pp (June 1970)
Refer to Abstract 70-642

The objective of the work described was to develop approximate equations for both the response of skin-stringer panels to turbulent boundary layer excitation, and the resulting acoustic radiation from the panels. The author gives a comprehensive account of the state-of-the-art in calculating the response of simple panels to turbulent boundary layers. Much of the work in this area has been done by other workers at Southampton University and the author summarizes the empirical data obtained from previous measurement of the wall pressure field beneath turbulent boundary layers. For predicting the panel response to the turbulent wall pressure field, the joint-acceptance method is employed.

The development from simple panel response to the more complicated skin-stringer panels is also well documented. Attempts are made to derive approximate solutions for the natural frequencies of stringer-bay modes. The acoustic power radiated is found from the computed radiation resistance and panel response. The author emphasizes the need for experimental data to establish the validity of the approach employed. In conclusion, this is a well-documented report suitable for both general readers and specialists in this area.

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TRANSIENT WAVEFORM CONTROL OF ELECTROMAGNETIC TEST EQUIPMENT
Favour, J.D.; LeBrun, J.M.; and Young, J.P.
J. Environmental Sci. 13 (4), 7-13
(July/Aug. 1970)
Refer to Abstract 70-629

This paper, originally presented at the 1969 Shock and Vibration Symposium, earned its authors the 1969 Vigness Award. It appears on page 157, Part 2, Bulletin 40 of The Shock and Vibration Bulletin, complete will all figures.

Shock tests may be classified in three ways: (1) specify the machine to be used (as in MIL-S-901); (2) specify the time history of the desired shock pulse (as in MIL-STD-810); or (3) specify the damage potential of the desired shock pulse in terms of frequency. This paper fits classification (2). It discusses a technique developed at Boeing in Seattle to produce specific time-history transient waveforms. The technique uses a digital computer and FFT algorithm. The article discusses a prototype system and its performance.

Most laboratories implement shock test specifications of classification (2) by means of shock test machines using gravity or other sources of energy. These are generally satisfactory for generating and controlling simple time histories such as haversines, sawtooths, etc.; but complex time histories are difficult to generate and control. This paper outlines one method, which appears to meet certain test requirements. One cannot predict how widely these particular tests will be used. Constraints of shaker stroke vs pulse time duration cannot be ignored.

It is my present opinion that the method of this paper will not be widely adopted. The trend seems to be toward classification (3); most laboratories using electromagnetic shakers for shock testing are meeting an energy vs frequency requirement.

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PASSIVE SHOCK ISOLATION (PARTS I AND II)
Ruzicka, J.E.
S/V Sound and Vibration 4 (8), 14-24 (Aug. 1970); and 4 (9), 10-21 (Sept. 1970)
Refer to Abstracts 70-673, 70-697

"Passive Shock Isolation" is a survey of shock isolation system design based on a single degree-of-freedom model using linear and nonlinear finite stiffness springs with varied analytical environmental descriptions. The problems of shock and vibration isolation are placed in proper perspective by the author, rendering the material interesting and of increased value. The confusion between shock and vibration isolation systems prevalent among designers should be resolved by these articles.

Ruzicka's papers consitute a clearly written, design oriented description of shock isolation using analytically derived data. The four basic tasks involved in the design of a shock isolation system are identified as: definition of the shock environment; specification of isolation system performance; analytical design of shock isolators; and hardware mechanization of analytical design.

The papers dwell solely on the first three tasks which are analytically oriented. A mathematical description of shock environments is obtained with simple analytical functions. Idealized forms of shock excitation including impulsive shock, velocity shock, free fall impact, acceleration shock pulses, and sustained loading are provided. From this point the author writes one of the best descriptions of the basic concept of shock isolation that I have read, and, in the process clearly delineates the difference between shock isolation and vibration isolation. The use of linear system static deflection is described and equations of motion for simple shock isolation systems with directly coupled viscous damping and elastically coupled viscous damping are provided.

Much good design data is given for shock isolation systems in the form of dimensionless response plots. The basis of the dimensionless response parameters is described clearly. Ruzicka points out pitfalls including that of assuming that the amplification factor equals transmissibility for other than zero damping. Curves for velocity shock with and without damping and velocity shock with elastically coupled damping are given in part I. Part II continues with response design data for a single degree-of-freedom shock isolation system with varied analytical shock pulse shapes. The design data on linear systems is concluded with response plots for systems under sustained loading. The shock spectrum concept of evaluating the dynamic response of isolation systems to specific environmental shock pulses is described.

The remainder of Part II contains an excellent discussion on isolation system design using isolators with nonlinear stiffness characteristics. Ruzicka discusses the role of the isolator's stiffness in tailoring the shock response. He notes that the ideal stiffness characteristic for a shock isolator has constant force with a magnitude equal to the allowable value of the transmitted force for all deflections greater than zero. This characteristic provides maximum energy storage and transmission at the allowable force for a given deflection. In addition, by having the allowable transmitted force present at all times, the shock isolator deflection is minimized. The ideal vibration isolator exerts zero force for all deflections until it bottoms.

Nonlinear isolator stiffness characteristics ranging between the ideal shock isolator and the ideal vibration isolator are identified and described. These isolators include linear, hardening, softening, buckling and bilinear behavior with respect to deflection. The author gives excellent design guidelines for the use of these nonlinear isolators. Design data is provided for velocity shock isolation with zero damping using nonlinear isolators with tangent elasticity, hyperbolic tangent elasticity, bilinear stiffness, and polynominal elasticity.

In the use of these articles for the design of shock isolation systems, your system must be capable of single degree-of-freedom response simulation. Isolators must have negligible mass compared to the isolated item, and the isolated item must be rigid compared to the isolator. For the majority of practical applications especially where low excitation frequencies and low loading rates are encountered, these assumptions are valid, and, as Ruzicka describes this technology, it is applicable. In rare instances such as environments involving explosions, nuclear detonations and artillery weapons with high loading rates, this technology does not give the complete system response because of the omission of the effects of isolator mass.

For ordinary design applications, Mr. Ruzicka has made a significant contribution to design oriented literature and I recommend its use by designers of packages, vehicles, and general machinery subject to shock environments.

R. E.

CALENDAR

Meeting	Date 1971	Location	Abstract Deadline	Contact
	JAN.			
Conference on Drilling and Rock Mechanics, SPE	Jan. (na)	Austin, Tex.	-	D.L.Ducate, SPE Hq.
Automotive Engineering Congress and Exposition, SAE	11-15	Detroit, Mich.	-	W.I.Marble, SAE Hq.
Reliability Symposium, IEEE, ASQC, ASNDT, IES	12-14	Washington, D.C.	-	J.E.Condon, Code KR, NASA Hq. Washington, D.C. 20546
Aerospace Sciences Meeting, AIAA	25-27	New York, N.Y.	Past	Meetings Manager, AIAA Hq.
	FEB.			
Reinforced Plastics and Composites Annual Conference, SPI	8 (na)	Washington, D.C.	-	R.T.Brennan, SPI Hq.
	MAR.			
Nuclear Engineering Conference, ASME	7-10	Palo Alto, Calif.	-	A.B.Conlin Jr., ASME Hq.
Seismological Society of America Spring National Meeting, SSA, GSA	25-27	Univ. Calif., Riverside, Calif.		D. Tocher, SSA Hq.
Gas Turbine Conference and Products Show, ASME	28-Apr.1	Houston, Tex.		A.B.Conlin Jr., ASME Hq.
	APR.			
National Telemetering Conference, IEEE	12-15	Washington, D.C.	-	IEEE Hq.
Diesel and Gas Engine Power Conference and Exhibit, ASME	18-22	Toronto, Canada		A.B.Conlin Jr., ASME Hq.
12th Structures, Structural Dynamics and Materials Conference, AIAA/ASME	19-21	Anaheim, Calif.		Meetings Manager, AIAA Hq.
Joint Railroad Conference, IEEE, ASME	19-21	New York, N.Y.		B.A.Ross, Am.Electrical Power Service Co. 2 Broadway, New York, N.Y. 10014
Design Engineering Conference and Show, ASME	19-22	New York, N.Y.		A.B.Conlin Jr., ASME Hq.
Pressure Vessels and Piping Conference, ASME	19-22	San Francisco, Calif.		A.B.Conlin Jr., ASME Hq.
National Meeting on Structural Engineering, ASCE	19-23	Baltimore, Md.	Feb.19	W.H.Wisely, ASCE Hq.
Conference on Composite Materials: Testing and Design, ASTM	20-22	Anaheim, Calif.		ASTM Hq.
Spring Meeting, ASA	20-23	Washington, D.C.	Jan.19	R.K.Eby, Polymers Div., National Bureau of Standards, Gaithersburg, Md. 20760
Symposium on Testing for Prediction of Material Performance in Structures and Components, ASTM, NMAB	21-23	Anaheim, Calif.	Past	Dr.R.S.Shane, NMAB, Natl. Academy Sci., 2101 Constitution Ave., N.W.Washington, D.C. 20418
Variable Geometry of Expandable Structures Conference, AAS, AIAA	21-23	Anaheim, Calif.	Past	F.W.Forbes, Tech.Activities, Office APO-1, AF Aero.Prop.Lab., WPAFB, Ohio 45433
17th Annual Meeting and Equipment Exposition, IES	26-30	Los Angeles, Calif.		T.W.H.Miller, IES Hq.
	MAY			
Packaging Conference, AMA	3-6	Chicago, Ill.	-	AMA Hq.
Fluids Engineering Conference, ASME	9-12	Pittsburgh, Pa.		A.B.Conlin Jr., ASME Hq.
Design Engineering Conference and Show, ASME	17-20	New York, N.Y.		A.B.Conlin Jr., ASME Hq.
Canadian Congress of Applied Mechanics, Central Committee for Canadian Congress of Appl. Mech.	17-21	Univ. Calgary Calgary, Canada	Jan.15	F.P.J.Rimrott, CCCCAM Hq.
National Conference on Environmental Effects on Aircraft and Propulsion Systems, NAPTC	18-20	Trenton, N.J.		R.J.Skeba, NAPTC, Box 176, 1440 Parkway Ave., Trenton, N.J. 08628
Spring Meeting, SESA	18-21	Salt Lake City, Utah	-	B.E.Rossi, SESA Hq.
American Helicopter Society Annual National Forum, AHS	26-28	Washington, D.C.	-	AHS Hq.

CALENDAR

Meeting	Date 1971	Location	Abstract Deadline	Contact
	JUNE			
Mid-Year Meeting, SAE	7-11	Montreal, Canada	-	W.I.Marble, SAE Hq.
Applied Mechanics Conference, ASME	23-25	Univ.Pa., Philadelphia, Pa.	Jan.4	A.B.Conlin Jr., ASME Hq.
Transportation Engineering Meeting, ASCE, ASME	25-30	Seattle, Wash.	-	
Annual Meeting, ASTM	27-July 2	Atlantic City, N.J.	Oct.15	J.B.Bidwell, ASTM Hq.
	JULY			
Reliability and Maintainability Conference, ASME	11-14	Long Beach, Calif.	-	A.B.Conlin Jr., ASME Hq.
Transportation Engineering Conference, ASCE, ASME	25-30	Seattle, Wash.	-	A.B.Conlin Jr., ASME Hq.
	AUG.			
National West Coast Meeting, SAE	16-19	Vancouver, Canada	-	W.I.Marble, SAE Hq.
Petroleum Mechanical Engineering Conference, ASME	19-23	Houston, Tex.	-	A.B.Conlin Jr., ASME Hq.
Applied Mechanics Western Conference, ASME	23-25	Los Angeles, Calif.	-	A.B.Conlin Jr., ASME Hq.
International Association for Shell Structures Meeting, IASS	29-Sept.9	Honolulu, Hawaii	-	Secretariat, c/o Univ.Hawaii, Director of the Center for Engineering Research, Honolulu, Hawaii
	SEPT.			
Lubrication Symposium, ASME	8-10	Toronto, Canada	Mar.15	A.B.Conlin Jr., ASME Hq.
Vibrations Conference, ASME	8-10	Toronto, Canada	-	A.B.Conlin Jr., ASME Hq.
Petroleum and Chemical Industrial Technical Conference, IEEE	13-15	Atlanta, Ga.	-	R.M.Emberson, IEEE Hq.
National Farm, Construction, and Industrial Machinery Meeting, SAE	13-16	Milwaukee, Wis.		W.I.Marble, SAE Hq.
National Aeronautic and Space Engineering and Manufacturing Meeting, SAE	27-Oct.1	Los Angeles, Calif.	-	W.I.Marble, SAE Hq.
	OCT.			
Lubrication Conference, ASME	11-14	Pittsburg, Pa.	-	A.B.Conlin Jr., ASME Hq.
Annual Fall Meeting, ASA	19-22	Denver, Colo.	July 20	R.C.Chanaud, Univ. Colo., Boulder, Colo. 80603
	NOV.			
Fall Joint Computer Conference, AFIPS	16-18	Las Vegas, Nev.	-	D.R.Crozen, AFIPS Hq.
Winter Annual Meeting, ASME	28-Dec.12	Washington, D.C.	-	A.B.Conlin Jr., ASME Hq.
	DEC.			
Ultrasonics Symposium, IEEE	6-8	Miami Beach, Fla.	-	R.M.Emberson, IEEE Hq.
	1972 JAN.			
Reliability Symposium, IEEE, ASQC, ASNT, IES	25-27	San Diego, Calif.	-	R.M.Emberson, IEEE Hq.
	MAR.			
Gas Turbine Conference and Products Show, ASME	26-30	San Francisco, Calif.	-	A.B.Conlin Jr., ASME Hq.
	APR.			
Spring Meeting, ASA	18-21	Buffalo, N.Y.	Jan.18	Betty H. Goodfriend, ASA Hq.
	MAY			
Design Engineering Conference and Show, ASME	8-11	Chicago, Ill.	-	A. B. Conlin Jr., ASME Hq.
Mid-Year Meeting, SAE	15-19	Chicago, Ill.	-	W.I.Marble, SAE Hq.
Spring Meeting and Exposition, SESA	23-26	Cleveland, Ohio	-	B.E.Rossi, SESA Hq.
	JUNE			
Lubrication Symposium, ASME	1-3	Boston, Mass.	-	A.B.Conlin Jr., ASME Hq.
Applied Mechanics Conference, ASME	26-28	La Jolla, Calif.	-	A.B.Conlin Jr., ASME Hq.

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SSA: Box 826, Berkeley, Calif. 94701

PERIODICALS SCANNED

Academie Polonaise de Sciences - Bulletin - Serie des Sciences Techniques, Warsaw, Poland.

Acoustical Society of America - Journal. New York, N.Y.

Acta Mechanica. Vienna, Austria.

Acustica, Stuttgart, West Germany.

Aeronautical Journal. London, England.

Aeronautical Quarterly. London, England.

Aeronautical Society of India. New Delhi, India.

AIAA Journal. New York, N.Y.

Akademiya Nauk. Izvestiya Mekhanika i Mashinostroenie. U.S.S.R.

American Helicopter Society - Journal. New York, N.Y.

American Society of Civil Engineers. New York, N.Y.
Proceedings
Journal of Engineering Mechanics Division
Journal of Soil Mechanics Foundations Division
Journal of Structural Division

American Society of Mechanical Engineers. New York, N.Y.
Transactions
Journal of Applied Mechanics
Journal of Basic Engineering
Journal of Engineering for Industry
Journal of Heat Transfer
Journal of Lubrication Technology

A.N. SSSR Otdelenie Tekhnicheskikh Nauk. Mekhanika i Mashinostroenie. U.S.S.R.

Applied Mathematics and Mechanics (Translation of Prikladnaya Matematika i Mekhanika) New York, N.Y.

Archiwum Mechaniki Stosowanej (Archives de Mechanique Appliquee). Warsaw, Poland.

ASLE - Transactions. New York, N.Y.

Automobile Engineer. London, England.

Automobiltechnische Zeitschrift. Stuttgart, West Germany.

Bauingenieur. Germany.

Brown Boveri Review. Baden, Switzerland.

Cambridge Philosophical Society - Proceedings. Cambridge, England.

Combustion, Explosion, and Shock Waves (Translation of Fizika Goreniya i Vzryva). New York, N.Y.

Environmental Quarterly. Little Neck, N.Y.

Experimental Mechanics. Westport, Connecticut.

Franklin Institute - Journal. Philadelphia, Pennsylvania.

Ingenieur - Archiv. Berlin, West Germany.

Institute of Marine Engineers - Transactions. London, England.

Institution of Engineers, Australia - Journal. Sydney, Australia.

Institution of Engineers - Mechanical Transactions. India.

Institution of Engineers and Shipbuilders in Scotland - Transactions. Glasgow, Scotland.

Institution of Mechanical Engineers - Proceedings. London, England.

Institution of Naval Architects - Transactions

Institution of Structural Engineers - Yearbook

International Congress on Acoustics

International Journal of Engineering Science. Oxford, England.

International Journal of Mechanical Sciences. New York, N.Y.

International Journal of Numerical Methods in Engineering. Sussex, England.

International Journal of Nonlinear Mechanics. New York, N.Y.

International Journal of Solids and Structures. New York, N.Y.

Israel Journal of Technology. Jerusalem, Israel.

Japan Society of Mechanical Engineers - Bulletin. Tokyo, Japan.

Journal de Mecanique. Paris, France.

Journal of Aircraft. New York, N.Y.

Journal of Composite Materials. Stamford, Connecticut.

Journal of Engineering Mathematics.

Journal of Environmental Sciences. Mt. Prospect, Illinois.

Journal of Mathematics and Mechanics. Bloomington, Indiana.

Journal of Mechanical Engineering Science. London, England.

Journal of Mechanics and Physics of Solids. Oxford, England.

Journal of Ship Research. New York, N.Y.

Journal of Sound and Vibration. London, England.

Journal of Spacecraft and Rockets. New York, N.Y.

Machine Design. Cleveland, Ohio.

Marine Engineer and Naval Architect. London, England.

Maschinenbautechnik. Berlin, West Germany.

Materials Research and Standards. Philadelphia, Pennsylvania.

Mechanical Engineering. New York, N.Y.

Midwestern Conference on Solid Mechanics - Proceedings.

Motortechnische Zeitschrift. Stuttgart, West Germany.

Nagoya University, Faculty of Engineering, Memoires. Nagoya, Japan.

Nuclear Engineering and Design. Amsterdam, Netherlands.

PMTF - Zhurnal Prikladnoi Mekhaniki i Tekhnicheskoi Fiziki. U.S.S.R.

Power Transmission Design. Cleveland, Ohio.

Quarterly Journal of Mechanics and Applied Mathematics. London, England.

SAE Journal. New York, N.Y.

Seismological Society of America - Bulletin. Baltimore, Maryland.

Shock and Vibration Bulletin. Washington, D.C.

SIAM Journal on Applied Mathematics. Philadelphia, Pennsylvania.

SIAM Journal of Control. Philadelphia, Pennsylvania.

SIAM Journal of Numerical Analysis. Philadelphia, Pennsylvania.

Simulation. San Diego, California.

Society of Automotive Engineers - Transactions. New York, N.Y.

Society of Naval Architects and Marine Engineers - Transactions. New York, N.Y.

South African Mechanical Engineer. Johannesburg, South Africa.

Soviet Physics - Acoustics (Translation of Akusticheskii Zhurnal by American Institute of Physics). New York, N.Y.

Statybine Mechanika. Mokslines - Technines Konferencijos Pranesimai. Kauno Politechnikos Institutas, Vilniaus Filialas.

S/V Sound and Vibration. Cleveland, Ohio.

Tohoku University- Technology Reports. Sendai, Japan.

U.S. NBS, Journal of Research, Engineering and Instrumentation.

U.S. National Congress on Applied Mechanics - Proceedings.

VDI, Zeitschrift. Duesseldorf, West Germany.

Vibrotechnika, Lietuvos TSR Aukstuju Mokyklu Mokslo Darbai, Vilnius.

Zeitschrift fuer Angewandte Mathematik und Mechanik. Berlin, East Germany.

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